As they mentioned, capillary stress failure appears to be central to the pathophysiology of this disorder as well as of other disorders, like high-altitude pulmonary edema. This topic is of great interest to us at the Naval Medical Center San Diego, where > 20 cases per year of pulmonary edema associated with surface swimming are evaluated. Generally, this condition occurs in special forces combat swimmers during intense training. Recently, three combat swimmers between the ages of 22 years and 28 years, without previous medical problems, simultaneously presented with unilateral radiographic findings of pulmonary edema. These patients were participating in a two-mile surface swim in 17°C ocean water. All were wearing 5-mm-thick neoprene wet suits that fit comfortably, all denied aspiration, and all complained of severe dyspnea and a nonproductive cough. Varying degrees of hypoxemia, tachypnea, and unilateral crackles (two right-sided and one left-sided) were observed. Radiographic findings included unilateral Kerley-B lines, cephalization, airspace consolidation, and normal cardiac size. Treatment consisted of supplemental oxygen and inhaled β-agonists. In each patient, hypoxemia resolved within 12 h, and results of chest radiographs normalized in 24 to 48 h. Navy combat swimmers swim primarily in a lateral decubitus position to allow constant eye contact with a partner and to maintain a low surface profile in the water. The dependent submersed lung was the radiographically affected lung in each of our three patients. We believe that increased central vascular volume associated with immersion, along with elevation of pulmonary vascular resistance and regional differences in perfusion secondary to the forces of gravity and high cardiac output, exposed regional capillaries to relatively high pressures. We believe that unilateral pulmonary edema, as observed in these combat swimmers, reflected global and regional pulmonary vascular changes that led to stress failure of the capillary bed.

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REFERENCES

Underwater Photography in the Human Airway

Use of Saline Solution to Visualize Peripheral Tumors and Evaluate Airway Rigidity

To the Editor:

Bronchoscopy is the most commonly used modality for establishing the diagnosis of lung cancer. The small size of peripheral human airways limits the scope of the flexible bronchoscope. When using flexible bronchoscopy, we use a technique of attempted saline distension to assess narrow segmental and subsegmental bronchi. The technique is used if a medium-sized airway appears abnormal or if a chest radiograph suggests a...
peripheral lesion in a particular segment, but no lesion is seen during the initial bronchoscopic inspection.

The technique of saline distension involves rapidly instilling 10 to 20 mL of 0.9% saline solution via the suction channel of a flexible bronchoscope that is wedged in a segmental or subsegmental bronchus. This saline distension often allows a more-distant view of the lesion and may indicate the nature of any narrowing, if present.

Saline distension is a technique that can reveal hidden peripheral tumors, and it can provide the operator with an immediate indication, at the time of flexible bronchoscopy, as to whether any area of narrowing in a segmental or subsegmental bronchus may be true or apparent. This, in turn, may help guide the physician in arranging the priority and urgency of future investigations. It may also help the bronchoscopist in deciding the type and amount of specimens to be taken from that area.

In a recent audit of a total of 319 flexible bronchoscopy procedures, carried out in our unit to investigate possible lung cancers during a 12-month period, the technique of saline distension was used in 47 cases. It was not associated with any significant complications. The technique of saline distension revealed hidden tumors in approximately 1% of all patients undergoing flexible bronchoscopy procedures, although the yield was much higher if used in a selected group of patients where a plain chest radiograph suggested a possible tumor in a medium-sized airway. The operator had made use of the technique in nine cases in which, on initial inspection, no lesion had been seen, despite a plain chest radiograph suggesting a likely tumor in a segmental or subsegmental bronchus. This technique revealed the presence of hidden tumors (not visible at routine bronchoscopy because of peripheral location; Fig 1) in three of these patients (one submucosal and two endobronchial tumors). All had positive brush cytology findings.

If the bronchoscope is wedged in a small bronchus, the saline solution will remain static, giving a clear view for a minute or more. This can allow “underwater” photographs and brush and biopsy samples to be taken. The technique can also provide a clear view in bronchi that are partially occluded by blood or mucus that cannot be aspirated due to the small size of the airways.

During inspection with a flexible bronchoscope, the operator may discover apparent narrowing of a segmental bronchus. Use of the technique of saline solution distension in this circumstance can help the bronchoscopist in the assessment of the underlying nature of the narrowing, although sensitivity will be low. If the bronchus distends easily when saline solution is instilled, this can help the bronchoscopist in deciding the type and amount of specimens to be taken from that area.

Saline distension is a technique that can reveal hidden peripheral tumors, and it can provide the operator with an immediate indication, at the time of flexible bronchoscopy, as to whether any area of narrowing in a segmental or subsegmental bronchus may be true or apparent. This, in turn, may help guide the physician in arranging the priority and urgency of future investigations. It may also help the bronchoscopist in deciding the type and amount of specimens to be taken from that area.

During inspection with a flexible bronchoscope, the operator may discover apparent narrowing of a segmental bronchus. Use of the technique of saline solution distension in this circumstance can help the bronchoscopist in the assessment of the underlying nature of the narrowing, although sensitivity will be low. If the bronchus distends easily when saline solution is instilled, this indicates that fixed narrowing due to peripheral tumor is less likely. There were 21 cases in our study in which a narrowed bronchus had easily distended with saline solution, revealing a macroscopically normal distal airway. All subjects had negative cytology findings, although 3 of 13 subjects did have CT-scan findings suggestive of peribronchial tumor. If the narrowed bronchus is nondistendable, the chances of an underlying tumor in the airway are much greater. In our study, 15 of 17 patients (88.2%) with a fixed narrow bronchus had evidence of a peribronchial tumor by cytology and/or histology results, or CT-scan findings. Only one patient had an apparently fixed narrow bronchus at flexible bronchoscopy but no evidence of tumor on a CT scan or from cytology/histology.

There is a strong correlation between an abnormal result during saline distension (ie, failure of bronchus to distend or distension revealing an endobronchial tumor) and the chances of either positive cytology/histology or abnormal CT-scan findings. The information is immediately available to the physician. The physician must remain aware that the technique should be used to give an indication, but it is not diagnostic of malignancy; other causes of airway rigidity, such as posttuberculous scarring, are possible in addition to malignant stenoses. This technique is both quick and easy to perform. It does not require any additional equipment by the bronchoscopy unit. In our own experience, it is not associated with any significant complications. We conclude that the technique of saline distension is a useful tool in the bronchoscopist’s armory.

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**Transient Lactic Acidosis as a Side Effect of Inhaled Salbutamol**

To the Editor:

Transient increase of lactate levels (lactatemia) with or without metabolic acidosis has been seldom reported as a complication of β-adrenergic agents administered during an asthma attack or for preterm labor therapy. The mechanism of this complication is poorly understood. In previous reports,1,2 lactatemia or lactic acidosis were associated with IV administration of β2-agonists or aminophylline, or a combination of inhaled β2-agonists and IV aminophylline.

During the last 6 months, transient lactatemia and/or lactic acidosis were observed in five patients admitted in our department for an asthma attack (Table 1). All of these patients were initially treated with 5 mg of inhaled salbutamol before blood gas (and lactic acid) analysis was performed. No IV bronchodilators were administered, and methylprednisolone, 40 mg/d, was ad-

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**Table 1—Functional and Metabolic Characteristics of Asthmatic Patients With Transient Lactatemia Attributed to the Administration of Inhaled Salbutamol**

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>FEV1, L</th>
<th>PO2, mm Hg</th>
<th>PCO2, mm Hg</th>
<th>Arterial pH</th>
<th>Lactate, mmol/L</th>
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<tr>
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<td>T2</td>
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<td>T2</td>
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<td>30</td>
</tr>
</tbody>
</table>

*T1 = measurement after first hour of treatment; T2 = measurement 24 h later.

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