# Lung Uptake of $^{99m}$Tc-Sulfur Colloid in Falciparum Malaria: Case Report

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***Increased lung uptake of $^{99m}$Tc-sulfur colloid was seen during liver scanning in a patient with falciparum malaria. This finding was due to the enhanced activity of the phagocytic cells of the reticuloendothelial system in the liver, spleen, and lung found in human and experimental malaria. Similar findings in other clinical situations and the relevant literature are reviewed.***

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An increasing number of reports describe significant lung uptake of $^{99m}$Tc-sulfur colloid, not attributable to technical factors, during routine liver scanning. This phenomenon has been seen in patients with liver transplants (*1*), spleen and bone marrow transplants (*2*), malignant lymphomas (*2,3*), metastatic carcinoma (*3–5*), intra-abdominal abscesses (*3*), and cirrhosis and other forms of liver disease (*3*).

This report describes similar intense lung uptake in a patient with falciparum malaria.

## CASE REPORT

The patient, a 22-year-old American woman married to a United States sailor living in Panama City, was admitted with a 4-day history of fever and chills, abdominal cramps, diarrhea, and vomiting. She also noted mild dysuria and frequent urination. She had not been outside the Panama City urban area.

Physical examination revealed a white woman in no acute distress. Temperature was 100.2°F, pulse 132, and blood pressure 110/60. Mild conjunctival icterus was present. Neck veins were flat. The chest was clear to auscultation. Examination of the heart revealed a sinus tachycardia and a grade II/VI midsystolic murmur along the right sternal border. The abdomen was soft and there was mild tenderness in both upper quadrants. No hepatosplenomegaly, adenopathy, or edema was noted.

Initial laboratory data revealed a white blood cell count of 3,500 with 85% polymorphonuclear cells and 13% lymphocytes. Hemoglobin was 13.7 gm and the sedimentation rate was 9 mm. Urinalysis revealed 1+ albumin, specific gravity 1.026, numerous red blood cells, 10–15 white blood cells, and coarse granular casts. Serum creatinine was 1.0 mg%, total bilirubin 3.8 mg%, direct bilirubin 3.1 mg%, SGOT 65, LDH 386, and alkaline phosphatase 241 IU (normal, up to 110). Total protein was 5.7 gm%, albumin 2.7 gm%. A chest x-ray was normal.

At first, hepatitis was suspected. However, the fever of 100–101°F persisted and the initial workup was not revealing. The vomiting and diarrhea resolved, but her course became complicated by increasing fever, progressive anemia, hypoalbuminemia, and edema. On the ninth hospital day, a liver scan was performed with $^{99m}$Tc-sulfur colloid, prepared by a method modified from Patton et al. (*6*), using an Ohio-Nuclear Twin Five rectilinear scanner. The scan (Fig. 1) revealed uneven uptake by the liver, which was significantly enlarged, and a spleen that approached the size of the liver. There was only slight uptake by the bone marrow, but significant uptake by the lung. The following day a malaria smear was found positive for falciparum malaria. Treatment was immediately started with chloroquine. She responded to treatment, but re-

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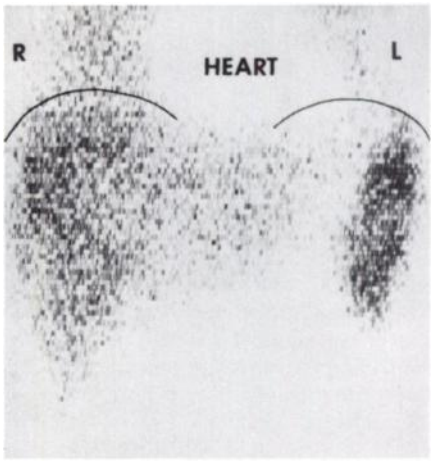


**FIG. 1.** Anterior view shows marked pulmonary concentration of $^{99m}$Tc-sulfur colloid during severe falciparum malaria.

covery was slowed by subsequent drug resistance which required the addition of Fansidar (sulfadoxine and Daraprim). She then recovered completely.

## DISCUSSION

Marked lung uptake of $^{99m}$Tc-sulfur colloid during routine liver scanning is unusual (*7*). Although this has often been attributed to technical factors (*8–10*), recent clinical and laboratory observations suggest that factors intrinsic to the patient may be responsible (*3*). Normally, colloids injected intravenously are extracted by the reticuloendothelial cells lining capillary walls predominantly in the liver, spleen, and bone marrow (*11*). Technetium-99m-sulfur colloid is 80% extracted in the liver, 15% by the spleen, and 5% by the bone marrow. Lung uptake is usually less than 1% (*7*). Although many of the patients described have liver damage, the increased lung uptake cannot be explained as merely compensatory, since in that situation the bone marrow would be expected to take up more colloid than the lung (*12*).

Recent data suggest that the increased lung uptake of $^{99m}$Tc-sulfur colloid is frequently due to increased pulmonary reticuloendothelial (RES) activity (*2*). Increased RES activity has been found in patients with both neoplasia and infection (*13–15*). Quinones (*16*) showed in rats that endotoxin, a known stimulator of the RES, causes a 20-fold increase in $^{99m}$Tc-sulfur colloid uptake in the lungs relative to the liver. This finding was confirmed by Klingensmith (*17*). The increased phagocytic activity in the lung could be due either to increased activity of the small number of macrophages normally present or to an increase in their number.

Studies have shown that macrophages are released into the circulation from the bone marrow and temporarily trapped in the pulmonary capillary bed before going on to the liver and spleen (*17*). In addition, rapid migration of large numbers of macrophages from the liver and spleen to the lungs has been seen in response to certain types of stress (*18,19*). Reticuloendothelial cells circulating in the intravascular space and fixed in the organs of the body can be increased by numerous stimulants including $B_{12}$, thyroid hormone, bacterial endotoxins, attenuated bacteria, foreign protein, and steroid hormones (*20*). Inflammation results in an elevated number of circulating macrophages secondary to an increased rate of formation and release from the bone marrow (*21*).

The fixed phagocytic cells of the RES (i.e., the Kupffer cells of the liver and sinusoidal lining cells of the spleen) have long been thought to play a major role in malaria. The liver RES cells probably collect the circulating sporozoites after the mosquito injects them into man, and during the erythrocytic phase of the disease the phagocytes of the RES serve as primary scavengers removing the debris of the host–parasite interaction (*22*). Clinically, the organs of the reticuloendothelial system usually become enlarged during malaria. The spleen becomes palpable in 70–80% of such patients and hepatic enlargement occurs in most (*22*). Histologically, this enlargement of the RES organs is primarily due to the tremendous hyperplasia and proliferation of macrophages. These phagocytic cells become extremely active as the infection progresses (*22*). Studies measuring the clearance of colloidal particles have shown that malaria in man is associated with enhanced phagocytic activity of the RES (*23*). Experimental malaria infection results in the accumulation of large numbers of macrophages in the pulmonary vascular bed. As the infection progresses, increasing numbers of these cells are observed lodging in the alveolar capillaries and adhering to the venous endothelium. After drug therapy, the number of pulmonary intravascular macrophages falls rapidly (*24*).

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