Pulmonary Disposition of Gallium-67 in Humans: Concise Communication

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Pulmonary gallium-67 imaging for inflammatory and neoplastic diseases has become an important diagnostic tool in respiratory medicine. However, the extent to which Ga-67 is delivered to normal lungs has not been fully evaluated. Accordingly, we measured the disposition of Ga-67 using scintiscanning, bronchoalveolar lavage (BAL), and blood analysis in healthy subjects. Following an intravenous dose of 6 mCi Ga-67 citrate, the gallium scan showed no pulmonary uptake at 48 hr. In all subjects, radioactivity was detected in both blood and recovered BAL fluid at 72 hr, being predominantly in the cellular component of the BAL washings. We conclude that despite negative pulmonary imaging, Ga-67 accumulates in the cells that line the alveolar acini of normal nonsmoking individuals.

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Since Edwards and Hayes (*1*) described the localization of gallium-67 in human tumors, this nuclide has achieved wide acceptance in the detection of occult sites of inflammation (*2,3*). In the diffuse interstitial lung diseases, Ga-67 scanning is used extensively to assess the extent and location of inflammatory activity and the response of the disease process to therapy (*4*). Imaging of normal lungs shows low or absent radioactivity (*4*), and in autopsy analysis, less than 1.5% administered dose/kg was found in lungs (*5*). However, it has been claimed that Ga-67, as detected by scintigraphic techniques, does not localize in normal lungs (*6*), although no studies have been reported in which tissue analysis was performed during life. Accordingly, we obtained for analysis bronchoalveolar lavage fluid in healthy, nonsmoking subjects, 72 hr after an intravenous dose of Ga-67 citrate. The lavage fluid was separated into cellular and supernatant components, each of which was counted separately. Our study has indicated that normal subjects accumulate radioactivity in their alveolar cells, although it remains undetected by conventional chest imaging.

METHODS

Four healthy, nonsmoking subjects (Table 1) received 6 mCi gallium citrate intravenously. All had normal pulmonary function tests and chest radiographs. At 48 hr after injection, anterior and posterior gallium scanning from neck to pelvis was performed with a rectilinear whole-body scanner.

After the potential hazards of bronchoscopy and topical anesthesia were explained, all subjects gave signed informed consent. They were premedicated with 5–10 mg diazepam, and were given oxygen by nasal catheter throughout the bronchoscopic procedure. Following routine inspection of the respiratory tract, the bronchoscope tip was wedged into a segmental bronchus of the lingula. Lavage was performed with five 20-ml aliquots of sterile saline. After injection of the saline, the fluid was suctioned (50–100 mm Hg negative) and collected in a sterile plastic sputum trap. Blood was drawn simultaneously for Ga-67 counting. In two subjects, lavage was also performed in the middle lobe.

Cell counts, differentials, and viability testing were done on the recovered bronchoalveolar lavage fluid as follows. To separate the cells, the specimens were filtered through 5-μm Millipore and 5-μm Gelman filters. A small portion was taken for cell count in a hemocytometer. The radioactivity of the BAL fluid and blood was counted in a single-channel sodium iodide detector with pulse-height analyzer set for Ga-67 (base 150, window 700). After counting, the BAL fluid was separated into cellular and cell-free components, using centrifugation of 500 *g* for 5 min. Each component was then counted. The cell pellet resuspended in Hanks' balanced salt so-

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TABLE 1. DISTRIBUTION OF GALLIUM-67 IN BRONCHOALVEOLAR LAVAGE (BAL) FLUID AND BLOOD OF NORMAL SUBJECTS

Subject	Age	Sex	BAL volume (ml)	BAL cell count/ml ($\times 10^{-5}$)	BAL cell differential (percent)			Radioactivity (net cpm/ml)		BAL supernatant (percent)	BAL cells
					P.A.M.*	L	N	Blood	BAL fluid		
1	44	M	30	1.7	90	9	1	50,532	545	5.3	94.7
			40	2.6	88	11	1	—	347	9.7	90.3
2	23	F	60	0.7	90	9	1	63,682	592	11.8	88.2
			50	0.9	93	7	0	—	245	16.5	83.5
3	34	F	55	1.6	94	2	4	50,965	536	12.1	87.9
4	30	M	30		92	5	3	—	773	8.0	92.0

* Pulmonary alveolar macrophages.

lution was stained (Wright-Giemsa) and a differential cell count performed.

RESULTS

The procedure was well tolerated and without complications in all subjects. Anterior and posterior rectilinear scans of the thorax and abdomen showed nonspecific Ga-67 uptake in the liver, spleen, and bones. The pulmonary tissues showed less tracer density than the soft tissues of the neck and shoulders, and were interpreted as normal. All subjects had detectable levels of radioactivity in both blood and recovered BAL fluid at 72 hr (Table 1). Radioactivity was associated predominantly with the cellular component of the lung washings, levels in the supernatant being in all cases less than 20% of the total. Proportional differential cell counts on the recovered BAL fluid indicated that the majority of cells were alveolar macrophages, further supporting the normality of the subjects studied.

DISCUSSION

The results indicate that after a standard dose of intravenous Ga-67, the tracer is found in cells that normally line the alveolar acinus. Bronchoalveolar lavage enables the cells and fluid in the alveolar epithelial surface to be sampled in a high state of purity (*7*). The harvested fluid has been shown to reflect accurately the acinar milieu in both health and disease (*8*). Much interest has focused on Ga-67 scanning in interstitial lung diseases as a noninvasive method for assessing the extent of the alveolitis component (*6*). In sarcoidosis, the disposition of Ga-67 at a pulmonary cellular level has been shown to be associated with the alveolar macrophages. Similarly, in fibrosing alveolitis, the Ga-67 radioactivity is distributed 2:1 between the alveolar macrophages and the polymorphonuclear leukocytes (*10*). Before the present study, the disposition of Ga-67 in normal lungs was not known, and the nuclide was thought not to localize in normal lung tissue (*6*).

These findings offer a new use of an established clinical technique for assessing the disposition of radionuclides in the lung. They have drawn attention to the fact that whereas during health Ga-67 is carried mainly in the plasma of the blood (*9*) rather than in the cellular component (chiefly polymorphonuclear leukocytes (*11*)), the reverse is true in the lung. BAL supernatant fluid contains transferrin (*7*), one of the major carriers of Ga-67 in the blood (*9*); yet in our study the supernatant contained less than one fifth of the total radioactivity. The BAL cellular component—in which lymphocytes and polymorphonuclear leukocytes formed a tenth or less of all the recovered cells—nevertheless contained most of the radioactivity. Thus, although alveolar cell separation was not attempted in the present study, other than for differential analysis, it seems reasonable to speculate that at least some, if not the majority, of the tracer is taken up by healthy alveolar macrophages. Although nonspecific uptake of Ga-67 is commonly seen at the time of scintigraphy in many normal tissues such as the breasts, bones, gastrointestinal tract, liver, spleen, and other soft tissues, we found it also in the normal lung cells of healthy individuals.

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