demonstrating a technique that is proving most useful to neurosurgeons, also raises the following points.

The laboratory calibration of Chervu et al. (*1*) determined a complex relation between the clearance of radionuclide injected into the Rickham reservoir and the flow rate in the shunt system they used. Their method required a graph of clearance values against predetermined flow rates for each reservoir and valve-reservoir combination. A much simpler and monoexponential relation exists for the Holter (*2*) and Cordis-Hakim valves (*3*), in their most useful range of flow rates, when the radiotracer is injected into the valve chamber. This allows a direct determination of the absolute flow rate from the known volume of the valve chamber (0.2 ml for the Cordis-Hakim adult model) and the slope of a log-linear activity-time curve obtained from a region of interest (ROI) around the injection site. The usefulness of this technique of shunt-flow measurement in 138 studies has recently been reported by us (*4*).

A further complication in the method of Chervu et al. (*1*) is the requirement for an external nonimaging detector that measures activity at the injection site for the first 6 min after injection, before the patient is placed beneath a gamma camera. In most nuclear medicine units, dedicated minicomputers are now associated with gamma cameras, and it is simpler to use the camera for the whole study. The clearance curve can be derived from a ROI that includes the injection site. No lead shielding is required. In addition, direct monitoring of the oscilloscope allows a valuable qualitative assessment of shunt patency, when radiotracer is seen to move distally. If the radionuclide injection has been made outside the shunt system, which happens rarely, this too can be recognized by the lack of distal motion, its punctate distribution, and the failure of digital pumping to move it along the shunt system.

The importance of position of the patient, and hence of the shunt, was rightly emphasized by Chervu et al. (*1*), for interpretation of their results. They found increased clearance for a given patient shunt in the erect position compared with the supine. We found that a high flow in the upright position usually indicates a patent shunt, even when flow is minimal or absent in the supine position (*4*). The patient's position before the examination must also be considered, for hyperdrainage can occur in ambulatory or seated patients, resulting in the measurement of low or absent flow in the supine position. Graham et al. (*5*) found it necessary to keep the patient supine for up to 45 min before the study. Our work similarly emphasizes this necessity and required at least two hours in the supine position before the examination (*4*). In this way the conditions for the flow measurement proved most reproducible.

We are sure the work of Chervu et al. (*1*) will help to persuade nuclear medicine and neurosurgical practitioners that there exists a simple, safe, and reliable method for determining the patency and flow rate of a ventricular shunt. They describe a clear, though complicated, analysis for a particular combination of reservoir and valve, and rightly emphasize that no assumptions can be made about a particular calibration remaining true, if further elements are added to the shunt downstream of the injection site. However there are shunts in common use for which the required calibration and use of both a gamma camera and another detector are not necessary. We trust this information will help to spread the good word about measuring ventricular shunt flow rates even further.

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Reply

We thank Dr. Wynchank et al. for their helpful letter discussing our article (*1*) on quantitative evaluation of CSF shunt flow. The value of the gamma camera in conjunction with a dedicated minicomputer to quantify the clearance of the activity from the site of injection is clearly a useful alternative method. It should be stressed that the camera technique and our probe technique both require the generation of a standard curve for a particular valve-reservoir combination in order to quantify the absolute CSF *flow rate*. With reference to the necessity for postural conditioning of the patient before quantification, our patients were kept supine for each measurement for a period of half an hour to one hour. We did not attempt to define an optimum time. It is a simple matter to generate a reference calibration curve for determination of such an important parameter as CSF shunt flow. This is a valuable nuclear medicine procedure, which may be performed with minimal effort at any routine nuclear medicine service with a simple thyroid counting probe or alternatively, as suggested by Wynchank et al., with a camera system.

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Re: An Automated Quantitative Analysis of Ventilation/Perfusion Lung Scintigrams

The paper entitled "An Automated Quantitative Analysis of Ventilation-Perfusion Lung Scintigrams" (*1*) contains several serious errors in basic pulmonary physiology. The perfusion images were performed with the subjects supine, but for the ventilation images they were upright. The $\dot{V}/\dot{Q}$ distributions thus derived are clearly invalid, as one cannot compare distributions of V and Q unless both are obtained in the same body position. That there is an apex-to-base gradient of increasing perfusion in the upright human lung is well known (*2*). There is, however, a significant apex-to-base gradient of increasing ventilation, also mediated by

gravity, in the upright position (*2*). Both of these gradients are eliminated with the subject supine. A $\dot{V}/\dot{Q}$ ratio calculated from a supine Q distribution but an upright V distribution is physiologically faulty.

Second, the implicit assumption made by the authors in dividing regional V as a percentage of total V by regional Q as a percentage of total Q is that the overall $\dot{V}/\dot{Q}$ of the lung is 1 (i.e., 100% divided by 100%). This may be nearly true in normal subjects, but is definitely not the case in most forms of lung disease (*3*). The meaning of $\dot{V}/\dot{Q}$ ratios derived using this assumption is physiologically unclear.

Third, the authors show, in Fig. 2D, that the derived $\dot{V}/\dot{Q}$ line in normal subjects is essentially equal to 1 uniformly from apex to base. Again, basic studies by West (*2*) have shown that the regional $\dot{V}/\dot{Q}$ varies from apex to base, because the ventilation gradient is less severe than the perfusion gradient. At the apex, the normal $\dot{V}/\dot{Q}$ ratio is close to 3, while at the lung base it is normally 0.3. Uniform $\dot{V}/\dot{Q}$ ratio is close to 3, while at the lung base it is normally 0.3. Uniform $\dot{V}/\dot{Q}$ ratios of 1 from apex to base, as shown by the authors, have never been seen in normal man.

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Reply

We agree, of course, with Dr. Horn's synopsis of the physiological determinants of ventilation and perfusion in the normal lung. It would be surprising if we didn't, since he has simply reiterated the last two paragraphs of our paper's discussion section.

Of course, we agree that the results we present are not "physiological." The investigation we seek to interpret is not physiological. If, however, Dr. Horn feels that because a lung image is not physiological it should not be used to aid diagnosis, then we disagree. Few radionuclide investigations satisfy strict physiological criteria, but it would be unwise to ignore them;—or does Dr. Horn feel that it is valid to interpret images but invalid to make measurements from them? If so, he would reject an imposing array of measurements, for example in cardiac and renal, as well as respiratory medicine.

The method we describe works perfectly well if both studies are done erect, but in this hospital and many others, lung-image patients are injected with pertechnetate while supine in order to improve visualization of the upper zones (because the distribution of Q while prone is almost exactly the same as the distribution of V erect, something that has been known in nuclear medicine for years).

The point of our paper, and of this letter, is that the combined krypton and Tc-MAA lung study contains an enormous amount of information that is routinely discarded. The distribution of radionuclides in lung disease is the result of pathophysiological processes, and those processes can be measured much more accurately by mathematical analysis than by simply looking at the pictures.

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