EVALUATION of the pathophysiology involved in the alteration of cerebrospinal fluid dynamics resulting in hydrocephalus has vexed observers for many years. More adequate means of investigation have been needed by the neurosurgeon, in particular, who must decide the feasibility of surgical intervention in each case encountered. Recognition of the effects of the disease presents no unusual problems. Marked ventricular dilatation and, in the infant, an enlarging head are common clinical entities. The problem arises in determining the activity of the disease. If active hydrocephalus is present, a shunting procedure may arrest destruction of the brain and result in actual regression of ventricular size. If the hydrocephalus is already arrested or compensated, surgical intervention may be contraindicated.

The dynamic nature of hydrocephalus requires serial contrast studies of the ventricles if anatomic indices of progression are to be used. The need for a test that would directly assess dynamics in hydrocephalus was appreciated by Dandy in 1914 when he studied the ventricular clearance of phenolsulfonphthalein and its subsequent appearance in the urine of hydrocephalics. The advent of radioisotope techniques has permitted the study of the constituents of cerebrospinal fluid with increased precision. The interpretation of data obtained from the appearance or disappearance of an isotope in a particular compartment of fluid requires caution, however. The possibility of confusing permeability and active transport has been well stated by Selverstone.

The choice of radioactive iodinated serum albumin (RISA) as the tracer for study of cerebrospinal fluid dynamics is reasonable since albumin is a naturally occurring component of the biological system under study, and not a substance completely foreign to the system. Significant work on the dynamics of the cerebrospinal fluid system using RISA as the tracer has already been done involving clearance of RISA from cerebrospinal fluid, brain, blood and body depots with the tracer injected into the ventricles as well as the blood stream. If we neglect the relationships between ependyma, neurones, glia, interstitial fluid and the physiologic significance of the various iodinated albumins (human, bovine, feline), our concept of RISA exchange can be diagrammed as in Fig. 1. The parameters used are in part the result of work by others and can be explained by reviewing the pathways designated by capital letters as follows:

A. Sweet and his co-workers found that the disappearance half-time of RISA placed in the ventricular system was about 2 hours in the normal human. This time was more than doubled in a patient with hydrocephalus.

B. The time required for equilibration of RISA from blood to cerebrospinal fluid was studied by Fishman and from cerebrospinal fluid to blood by van Wart. Both of these studies were carried out in laboratory animals and both showed an equilibration time of 16 to 20 hours.

C. Lee and Olszewski studied the uptake of radioiodinated bovine albumin from the
cerebrospinal fluid into the brain using radioautographs. They found the uptake of isotope by deeper structures most intense at 3 hours. There was decreased activity through the whole brain at 16 hours, and clearing occurred by 24 hours. They postulated entry of the tracer into the brain until the concentration in the cerebrospinal fluid was the same as that in the brain.

D. Storassli et al.\textsuperscript{11} studied the disappearance of RISA from the blood in humans. The concentration in blood decreased 10 per cent in 1 hour.

E. Storassli et al. also found the rate of urinary excretion was 8 to 12 per cent in 24 hours.

If RISA placed in the cerebrospinal fluid rapidly enters the brain, reaching equilibrium in about 3 hours,\textsuperscript{9} and the combined cerebrospinal fluid-brain compartment then reaches equilibrium with the blood about 20 hours following injection of RISA, the concentration of RISA in cerebrospinal fluid would decrease at a decreasing rate consistent with the data. Inherent in this model is the concept that the passage of RISA into the brain is more rapid than the passage of RISA into the blood from either cerebrospinal fluid or brain.

The present study was designed to provide information regarding the activity of the hydrocephalic process in patients being considered for various shunting procedures. Some limitations were imposed to keep the test simple enough to be of routine value in the hospital situation. The test measures the disappearance of RISA (radioiodinated human serum albumin) from the lateral ventricles and, in some cases, the appearance of the tracer in the blood.

**MATERIALS AND METHODS**

Studies were carried out in 22 patients ranging in age from 4 to 69 years. Of these studies, 21 evaluated transfer of RISA from ventricular cerebrospinal fluid into blood and 2 evaluated transfer from blood to cerebrospinal fluid. Lumbar and ventricular cerebrospinal fluid was studied in 3 patients. All patients studied had proven hydrocephalus (obstructed or communicating type) or were presumed to have hydrocephalus. None had neoplasm of the brain or meninges. Eleven had had ventriculo-atrial shunts (Pudenz-Heyer valves) placed from 3 years to 2 months prior to the study.

Following ventricular puncture through a twist-drill hole, 5 microcuries of RISA (0.1–0.2 ml. volume) were injected into the lateral ventricle. Samples of blood were taken at 5 minutes, 10 minutes, 1 hour, 4 hours, 12 hours and 24 hours. Samples of ventricular cerebrospinal fluid (1 ml.) were taken at 1 hour, 4 hours, and 24 hours. Samples of blood and cerebrospinal fluid were placed in sealed, previously weighed tubes. The tubes were weighed again to determine the amount of the sample to 1 per cent by weight. No correction was made for specific gravity in the conversion from weight to volume (approximate error less than 1 per cent). The samples were counted in a Picker model 2304 well-counter utilizing a thallium-activated sodium-iodide crystal. Corrections were made for isotope decay and background activity. No corrections were made from dependency of counting rate on sample volume since the count for a given amount of \(^{111}\text{I}\) varied only 2 per cent when the sample volume varied from 1 to 4 ml. Samples with counting rates less than twice the background rate were rejected.

The 1-hour sample proved to be an unreliable index of activity of transfer, possibly because of marked variation in volume of ventricular cerebrospinal fluid. The approximate mean activity of the 1-hour ventricular fluid