TABLE I.
Results in One Animal with Constriction of Left Atrium.

Procedure, shunt open	Aortic pressure, S/D	Initial tension of right ventricle, mm/Hg	M^2 body surface: Blood flow through shunt, cc/min.	M^2 body surface: Cardiac output, cc/min.	Cardiac rate
Control	138/112	22	37	3600	186
Shortly after constrict.	154/122	24	95	3300	186
30 min. constrict.	160/126	28	126	3300	168
Constrict. removed	128/ 98	22	55	3900	174
Shortly after constrict. removed	134/ 96	18	34	4030	174

(1). Shunting of blood through a large extracardiac shunt might lower pulmonary vascular pressure to such an extent that it would be insufficient to overcome the obstructed inlet to the left ventricle, and the possibility of overburdening the right ventricle with increased venous return might exist. The capacity of the shunt in our acute experiments could be increased up to 8% of the cardiac output. An effort to further increase the capacity of the shunt by rapidly infusing acacia intravenously, thereby increasing venous return and overloading the right ventricle, was not successful. One cannot conclude from acute experiments of this type that the maximum shunt flow was obtained. Although the cardiac output was diminished, there was no conclusive evidence that the presence of the venous shunt interfered with the filling of the left ventricle. Evidence of right ventricular strain by virtue of a rise in initial tension was found in only 2 of the animals. This was also noted to be variable by Katz and Siegel in their study (4). In addition, the increase of venous return, a consequence of the presence of the shunt, gave no evidence that an added burden was placed on the right ventricle. In this regard the effects over a prolonged period remain to be elucidated.

Conclusions. 1. In acute experiments producing increased pulmonary vascular pressure in dogs, the capacity of a pulmonary vein-azygous vein shunt was found to be up to 8% of the total cardiac output.

2. There was no consistent evidence that the presence of the shunt produced or added to the strain on the right ventricle or interfered with the filling pressure of the left ventricle.

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Maternal Nutrition and Hydrocephalus in Newborn Rats.* (17881)

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It is well known that female rats reproduce readily on synthetic diets, but Richardson and Hogan(1) reported that 1.7% of the young in their colony developed hydrocephalus, due to a deficiency in the maternal diet. O'Dell, Whitley and Hogan(2) observed that when folic acid was added to the diet used by Richardson and Hogan the incidence of

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1. Richardson, L. R., and Hogan, A. G., *J. Nutrition*, 1946, v32, 459.

2. O'Dell, B. L., Whitley, J. R., and Hogan, A. G., PROC. SOC. EXP. BIOL. AND MED., 1948, v69, 272.

hydrocephalus was sharply reduced. This observation confirmed the nutritional origin of the abnormality and suggested that the incidence would be increased if the folic acid deficiency were sufficiently severe. The object of this paper is to describe the procedure, and the results obtained, in our attempt to limit the amount of folic acid that was available to the experimental animals.

Experimental. In previous studies all rats had consumed synthetic diets, with casein as the source of protein. However, it was observed in a parallel study not described in this report, that there were a few cases of hydrocephalus in the young of females on a diet in which the protein was supplied by soybean oil meal. The reproductive record was excellent in all other respects and it was decided to use both the casein diet, No. 1953, and the soybean oil meal diet, No. 2087, in further studies of hydrocephalus. The incidence of the abnormality remained distressingly low and it was assumed that the rats had obtained sufficient folic acid, as a result of intestinal synthesis, to prevent all but a few cases of hydrocephalus. In an effort to reduce the amount of available folic acid a folic acid antagonist, crude methylfolic acid†, was added to the soybean oil meal diet, No. 2087. One of the new diets, No. 2115, contained 1 mg of the antagonist per 100 g. The other, No. 2116, contained 2 mg. The results obtained with these diets were approximately the same and are all ascribed to No. 2115 to simplify the presentation. These new rations, of which 2115 is an example, were consumed by all rats during the period included in this report. During the pre-experimental period some of them had received (a) the soybean oil meal diet, No. 2087, (b) others had received the casein diet, No. 1953, and (c) another group had received the stock diet, on which our rat colony is maintained. The more important diets are described in Table I and the results summarized in Table II. The incidence of hydrocephalus, at least for some months, depended on the diet the females had consumed before the folic acid antagonist was included in the diet. For that reason the results obtained with rats that consumed the soybean oil meal diet before the antagonist was added will be discussed first.

TABLE I.
Composition of Experimental Diets.

Ration No.	1953	2087
	g	g
Casein (Vit. test)*	30	—
Soybean oil meal	—	70
Cerelose	52	22
Wood pulp	3	—
Lard	10	4
Salts†	5	4
Added vitamins,‡ both diets		
		mg
Thiamine HCl		1.6
Riboflavin		1.6
Pyridoxine HCl		1.6
Ca-pantothenate		4.
Choline chloride		100.
Biotin		0.02
Alpha tocopherol		1.
2-methyl-1,4-naphthoquinone		1.
Vit. A		2000 I.U.
Vit. D		285 I.U.

* Nutritional Biochemicals Corp., Cleveland, O.
† Richardson and Hogan(1).
‡ Vit. A and D were supplied in the form of oleum percomorphum, Mead Johnson & Co. All other vitamins were supplied through the courtesy of Dr. D. F. Green, Merck & Co., Rahway, N. J.

a. *Soybean oil meal diet during the preperiod.* The first hydrocephalic rat in this group was born 19 days after the folic acid antagonist was added to the diet of the mother. On the 29th day after the change a litter of 13 was born, all of which were hydrocephalics. If this litter is excepted, the number of hydrocephalics per litter has varied from 0 to 6. Over half of the litters contained at least one hydrocephalic, and over 20% of all young born had hydrocephalus. One female bore 19 young with 14 hydrocephalics, distributed among each of her 4 litters. Another bore 5 litters with 23 young. There were 3 hydrocephalics distributed between 2 litters.

b. *Casein diet during the preperiod.* It will be observed in Table II that the incidence of hydrocephalus was quite low in the 1st and 2nd litters borne by females in this group, and there was a definite increase in their 3rd litters. There were only three 4th

† Generously supplied by T. H. Jukes of the Lederle Laboratories, Pearl River, N. Y.

TABLE II.
Maternal Nutrition and Incidence of Hydrocephalus in the Offspring.

Days on exp.	Litter order	No. of litters		No. of young			
		Total	With hydrocephalic young	Total	Born dead	Hydrocephalic	Survived 28 days
A. Ration 2087 before transfer to experimental diet							
19–68	1	12	6	115	0	25	32
55–135	2	12	8	88	6	18	13
83–144	3	12	7	71	3	18	18
111–151	4	6	4	41	2	10	10
139	5	1	1	5	1	1	0
B. Ration 1953 before transfer to experimental diet							
14–78	1	13	1	115	4	1	78
68–144	2	13	1	78	5	2	55
103–155	3	7	3	55	5	5	7
139–158	4	3	2	12	0	3	0
C. Stock ration before transfer to experimental diet							
58–102	1	10	1	79	4	1	20
88–109	2	4	0	27	3	0	1

litters but it is significant that the percentage of hydrocephalics rose to practically the same level as was reported in Section A.

c. *Stock diet during the preperiod.* The last group has been under observation a shorter time than the others and was made up of females that were transferred directly from the stock diet to Ration 2115. In 109 days after the change in diet 14 litters were born, containing 106 young, with one hydrocephalic.

During the period covered in this paper, all cases of hydrocephalus recorded were detected at birth and none developed later. If distortion of the skull is too slight for a sure diagnosis, doubtful cases are usually diagnosed with certainty by observing the intensity of the transmitted light when the head is held in a strong beam of light in a line with the eye of the observer. Practically all of the hydrocephalics have died within 3 or 4 days and only 3 out of a total of 72 have survived as long as 3 weeks.

Discussion. There is no doubt that the incidence of hydrocephalus can be greatly increased by adding the methylfolic acid antagonist to the diet, but the cause of the increase is as yet uncertain. It may be relatively simple, and merely due to a more severe deficiency of folic acid. On the other hand it is conceivable that methylfolic acid has some specific toxic effect and hydrocephalus is the result of a structural or biochemical derangement that is unrelated to a folic acid deficiency. Gillman, Gilbert and Gillman(3) injected female rats with trypan blue, and observed that 7.3% of their young were hydrocephalics. We had no difficulty in confirming this observation. One could assume that the initial damage was the same whether trypan blue or methylfolic acid was administered to the females.

Another point that deserves some consideration is the long delay in the appearance of hydrocephalic young when the females were transferred from the casein diet to the soybean oil meal diet which contained a folic acid antagonist. The casein diet did not contain folic acid and one would not suppose that a long period would be required to reduce the tissue reserves to a critical level. It may be that still another nutrient is involved in the development of hydrocephalus, and we are considering the possibility that it is vitamin B_{12}. The stock diet undoubtedly contains it, and according to our microbiological assay the casein used contained 1.8 μg %. The soybean oil meal has not been assayed but we know it is a poor source of this vitamin. However, the possibility is not excluded

3. Gillman, J., Gilbert, Christine, and Gillman, T., *S. Afr. J. Med. Sci.*, 1948, v13, 47.

that an unrecognized nutrient is implicated.

Hydrocephalus has been reported in various animal species though it is too rare to be of any practical significance in livestock production. It occurs in human infants, and though uncommon it is of some consequence. No satisfactory explanation of these cases has been advanced but it seems plausible now that many at least are the result of a nutritional deficiency. This possibility raises a question that deserves serious consideration; is there any wide variation in the severity of the symptoms. Up to the present hydrocephalus seems to be an all or none phenomenon but an attempt will be made to determine whether mild cases occur that escape detection by the method used in the past. The possibility of tissue or functional damage, with no gross symptoms of injury, deserves serious study.

Summary. Female rats were supplied with an experimental diet that contained soybean oil meal as a source of protein, and a vitamin mixture that included all recognized vitamins except ascorbic acid, niacin, folic acid and B_{12}. The incidence of hydrocephalus in the young was less than 1%. When folic acid antagonist was added to this diet the incidence of hydrocephalus rose to 20%. The type of diet consumed during the pre-experimental period determined the amount of time that elapsed, during the experimental period, before hydrocephalus appeared in the young.

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The Cockroach as an Experimental Vector of the Virus of Spontaneous Mouse Encephalomyelitis (Theiler).* (17882)

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The natural modes of transmission for the polio-encephalomyelitis group of viruses are not understood(1,2). A commonly accepted epidemiological hypothesis encompasses a fecal-oral spread and the alimentary tract as the portal of entry. In support of this hypothesis is the finding of virus in the intestinal tract, stools, sewage, and flies. The demonstration(3) that virus persists in non-biting flies for days, and possibly multiplies, suggests that members of the polio-encephalomyelitic group of viruses escape the intestinal-oral carrier chain in their natural mammalian hosts to utilize arthropods for the maintenance and passage of virus to new hosts. Attempts to incriminate mosquitoes(4-6) have been unsuccessful. Lice(7) and fleas(8,9) were found incapable of transmitting the virus of human poliomyelitis. Since the capacity of cockroaches† for the maintenance and transmission of viruses has been little

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