of these precautions food spillage invariably occurred. Where nitrogen intake is determined from the weight of food eaten or where the caloric intake is being followed, spillage may be a large source of error. It was found that the individual cages used by White or by ourselves gave incomplete separation of the urine and feces. Difficulty was also experienced in cleaning the fine screens. Poor ventilation is evident when the feces are not removed daily. Loss in ammonia, however, was reduced by putting 25% sulphuric acid in the bottom of the mouse jar. It was observed that mice kept in individual cages ate less and did not maintain their weight as well as mice kept together in larger cages. Similar observations have been made by Brunschwig *et al.*[3]

To overcome the objections inherent in these methods of management of the mice, the metabolism chamber shown in Fig. 1 was devised. It was designed to accommodate 10 mice. It consists of a metal cage 12″ x 10″ x 5″ with a single floor of No. 3 gauge screen, 2 inches from the bottom. This fits over a glass tray. Five feeding holes, ⅝″ in diameter, are in each of 2 opposite walls. These holes are opposite recesses in a 1-inch board which forms part of an outer frame into which the metal cage fits, but which is offset ⅜″ from the metal wall. The recesses, ⅞″ in diameter, are depressed at an angle of 20° and are receptacles for the glass food cups. A wooden gate acts as the back-stop and enables the food cups to be inserted one at a time. The glass food cups are cut to fit the oblique hole so that there is a space of 3/16″ between the edge of the cup and the wall. Inside and touching the wall below each set of feeding holes is a movable metal tray kept in a position by 2 metal projections into the screen floor. A sliding screen cover furnishes adequate ventilation. Water bottles are inserted through the screen mesh. The whole assembly sits on a sheet of clean paper.

This experimental set-up solves the problem of spillage and fouling of the food. The mouse can reach the bottom of the feed cup but does not pull food into the cage. Any food pulled out of the cup drops between the metal wall and the wooden frame to the clean paper. Occasionally some food may stick to the head of the animal and subsequently be dislodged when the mouse again pokes its head into the feed hole. This material drops to the metal tray, and is recovered. Spillage was reduced to a minimum when the diet had the consistence of toothpaste.

Summary. A cage for the proper management of mice during nitrogen balance studies is described. The arrangement eliminates spillage of food, fouling by excreta, loss of ammonia, and other sources of error.

3 Brunschwig, A., and Rasmassen, R. A., *Cancer Research*, 1941, **1**, 371.

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Autoantibodies in Rheumatic Fever.*

PHILIP A. CAVELTI. (Introduced by K. F. Meyer.)

From the George Williams Hooper Foundation for Medical Research and the Division of Medicine of the University of California Medical School, San Francisco, California.

As reported previously[1,2,3] autoantibodies to kidney can be produced by immunization of animals with mixtures of group A streptococci and kidney of the same species. The streptococci thereby confer antigenicity on renal material which, as such, is nonantigenic in the homologous species. The autoantibodies to kidney thus formed react specifically with plain normal homologous kidney as demonstrated *in vitro* by the collodion par-

* This investigation was aided by grants from the Commonwealth Fund.

1 Cavelti, Philip A., and Cavelti, Else S., *Arch. Path.*, 1945, **39**, 148.

2 *Idem., Arch. Path.*, 1945, **40**, 158.

3 *Idem., Arch. Path.*, 1945, **40**, 163.

ticle technic. Their *in vivo* effect is the production of glomerulonephritis by means of their reaction with the immunized animal's own kidney.

It is thus conceivable that human glomerulonephritis also might be due to the pathogenic action of specific nephrotoxic autoantibodies produced as a response to an antigen resulting from a combination of streptococcal and renal material during the streptococcal infection, which commonly precedes glomerulonephritis by about 2 weeks.

Investigations as to whether substances from other homologous tissues, besides kidney, also might be rendered antigenic by combination with streptococci, and as to the lesions resulting from such autoantibodies, are under way and will be reported later; however, it can be stated that autoantibodies to heart, skeletal muscle, and connective tissue can be produced in this manner.

These results together with the fact that, similar to glomerulonephritis, rheumatic fever also is preceded by a streptococcal infection, suggest the possibility that autoantibodies to certain tissues might play a role in this disease.

Attempts were undertaken to demonstrate in the serum of patients with acute rheumatic fever, autoantibodies to human heart, the organ most regularly affected by this disease. The purpose of this paper is to present a short report on the results obtained so far in this phase of the studies.

Material and Methods. The antigens employed were saline extracts of human heart. Control serums were obtained (a) from normal persons and (b) from blood samples taken for routine laboratory tests from patients of the University of California Hospital in San Francisco. These controls therefore represent a diverse and unselected group of patients. The sera of patients with acute rheumatic fever were obtained from various local sources.

As serologic method the collodion particle technic[4] was employed. Appropriate constant amounts of collodion particles sensitized with extract of human heart were added to a series of tubes containing progressive dilutions of the serum to be tested. After an incubation of one hour at room temperature, the tubes were centrifuged for 3 minutes at 1,400 revolutions per minute. The results were read while the tubes were carefully shaken. Agglutination was recorded from plus-minus to 4-plus. In tubes in which no agglutination had occurred, the collodion particles could readily be resuspended smoothly, so that no particles could be seen by the naked eye.

Results. Antibodies to human heart were demonstrated in the majority of the samples tested from patients with active rheumatic fever. The titers, in terms of serum dilutions, varied between about 1:40 and 1:320. The serums of 36 patients have been tested so far. Strong positive reactions (2-plus or stronger) were recorded in 20 of these patients; weak, but definitely positive tests were obtained in 7 cases, and the remaining 9 patients showed doubtful or negative reactions.

From many cases repeated samples of serum were obtained at intervals of 2 to 5 weeks. Thus the total number of serums taken from patients with rheumatic fever tested so far is 67; of these, 47 gave definitely positive reactions.

The most satisfactory antigen was obtained from the heart of a case of postoperative pulmonary embolism. Extracts from 3 other human hearts, however, also gave positive reactions with serum of rheumatic patients.

Controls. (a) The serums of 12 normal persons all gave completely negative results; (b) of serums from 84 patients with various diseases, one (a case of chronic myeloid leukemia) was weakly positive and three others gave a doubtful reaction; the remaining 80 failed to give any serologic reaction with human heart.

Comment. From the results obtained so far it appears that, in general, these autoantibodies to heart are present during the early and most active stages of the disease and disappear when the rheumatic process becomes inactive. Thus most, if not all, of the cases which gave negative serologic tests seemed to be well on the way to recovery. On the other hand, a few cases have been observed which gave particularly strong serologic reac-

[4] Cavelti, Philip A., *J. Immunol.*, 1944, **49**, 365.

tions with human heart and in which the reaction persisted, although quantitatively decreasing, up to a time when the rheumatic process seemed to have become inactive clinically.

Studies on a larger scale on the various aspects of the serologic phenomenon described are under way and will be reported upon completion.

Summary. From the results reported it would seem that the presence of autoantibodies to human heart has been demonstrated in 75% of a group of patients with acute rheumatic fever.

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Recuperation from the Effects of Tenotomy on Neuromuscular Transmission.*

P. THOMSEN AND J. V. LUCO.

From the Department of Pharmacology and Biological Chemistry, Catholic University of Chile.

Thomsen, Altamirano, and Luco[1] demonstrated the following changes, related to transmission in muscles 3 to 15 days after transection of their tendons: (a) greater development of tension in the third stages of muscular contraction relative to the first (see Rosenblueth and Cannon[2]); (b) diminished or abolished post-tetanic potentiation; (c) decreased sensitivity to curare; (d) more intense post-tetanic decurarization. We believed it would be of interest to study neural transmission in muscles which had undergone tenotomy but which had spontaneously re-established continuity of the tendon.

Method. The experiments were conducted on the soleus muscle of the cat 1.5 to 4 months after section of the Achilles tendon. In each study the responses of the operated muscle were inscribed on a drum, the homologous muscle of the opposite extremity being used as a control. Each tibia was fixed with clamps and the tendon attached to the short arm of a lever which exerted traction on elastic bands. The popliteal nerve was stimulated. Curare Merck was administered intravenously.

Results. The findings can be grouped into 3 separate categories: In the first, in which 3 cats were studied, 4, 4, and 3 months after tenotomy, the walk was the same as in recently tenotomized cats, re-establishment of the tendon not having occurred. In these the muscular atrophy was marked and the development of tension so slight that detailed studies were not carried out. In the second series 3 cats 4, 1.5, and 1.5 months after tenotomy were studied. In all of them the walk was improved and the tendon showed a greater degree of re-establishment than in the first group. Response to the stimulation of the nerve with high frequencies (250-500 per second) was equal to that of normal muscle: however, the graph was more like that of a recently tenotomized subject in responses to lower frequencies, in post-tetanic potentiation, and in sensitivity to curare. In the third series in which 4 cats of 4, 3, 3, and 1.5 months after tenotomy were studied, the walk was normalized and the tendon has practically re-established its former status. The responses to all frequencies of stimulation were within normal expectations. Post-tetanic potentiation was present in only 2 of the 3 cases studied. The sensitivity to curare had not only returned fully, but was actually in excess of normal. The tension developed by the muscle with re-established tendon is only one-half to one-third that of normal muscle.

Discussion. The observations made in this study reveal that it is possible to obtain a restoration of the normal function of neuromuscular transmission altered by transection of the tendon. This restoration does not occur in an abrupt form; that is, the various changes

* Aided by the Ella Sachs Plotz Foundation.

1 Thomsen, P., Altamirano, M., y Luco, J. V., *Medicina* (Buenos Aires), 1942, **3**, 67.

2 Rosenblueth, A., and Cannon, W. B., *Am. J. Physiol.*, 1940, **130**, 205.