agent. There is no information as to whether or not humans will react to contact with scrapie agent as do sheep or goats or in a manner similar to the behavior of mice, or in a manner like none of these hosts. We have inoculated 4 Macaca (rhesus) monkeys both intracutaneously and intravenously with the mouse scrapie agent (10% brain in buffered saline) and to date, after 14 months of observation, no signs of disease have appeared in the monkeys. It seems appropriate to emphasize that precautions employed to prevent spread of conventional viral agents to man and mice might not be sufficient in work with scrapie. In this connection the still unverified observations of Palsson, Pattison and Field(8) of the emergence of a scrapie-like condition in sheep inoculated with brain material from an acute case of multiple sclerosis demands attention. Either there is more spontaneous scrapie in "control" sheep than the investigators suspect, or the multiple sclerosis brain material has provoked or activated a scrapie-like process.

The total experience with scrapie emphasizes the urgent need to develop a specific serologic test for scrapie. Such a test will not only find wide use in veterinary medicine but might also be of help in determining whether or not scrapie is of potential or real danger to man.

Summary. Scrapie occured in 7 of 200 uninoculated control mice housed in the same room with, but caged separately from, successive groups of scrapie inoculated mice. Clinical evidence of the disease appeared in controls as early as 16 months and as late as 22 months after initial exposure to scrapie inoculated mice.

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Magnesium and Potassium Metabolism in Patients with Idiopathic Cardiomyopathy and Chronic Congestive Heart Failure.* (30459)

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Magnesium and potassium are among the most abundant cations in the human body. Both are predominantly intracellular and both have many pathophysiologic and pharmacologic similarities. It has been shown for human skeletal muscle that primary excess or deficiency of potassium is usually accompanied by concordant changes in magnesium content(1). Primary magnesium deficit has been reported to induce an increase in excretion of potassium(2). In acute renal diseases both serum magnesium and potassium are increased(3-5). In diabetic acidosis and also during recovery, magnesium follows a metabolic pattern similar in many ways to that of potassium(3,6,7). Both magnesium and potassium ions depress the cardiac ac-

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TABLE I. Clinical Data on 6 Subjects Studied.

Subject	Age	Sex	Diagnosis	Therapy
			Control subjects	
J.M.	48	♂	Cardiomyopathy without CHF	
B.S.	44	♀	Psychoneurosis	Phenobarbital
			Patients with idiopathic cardiomyopathy and congestive heart failure	
J.T.	55	♂	Cardiomyopathy with moderately severe CHF	Digitalis Quinidine Phenobarbital
M.M.	49	♀	Cardiomyopathy with moderately severe CHF; diabetes mellitus	Digitalis Quinidine Belladonna NPH insulin
A.T.	54	♂	Cardiomyopathy with severe CHF	Digitalis Mercuhydrin® Ammonium chloride Phenobarbital
O.J.	56	♀	Cardiomyopathy with severe CHF	Digitalis

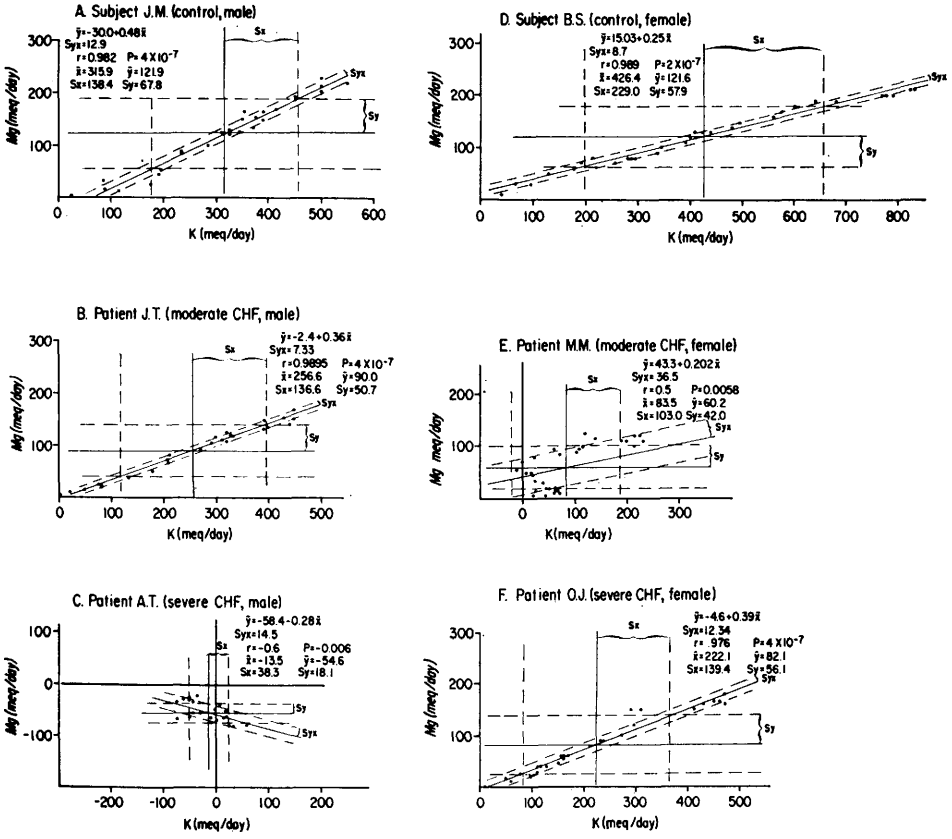

FIG. 1, A-F. Relationship between daily cumulative balances of Mg and K in 2 control subjects and 4 patients with idiopathic cardiomyopathy and chronic congestive heart failure. Continuous oblique line is regression line and its parallel interrupted lines are standard deviations of regression line. Continuous horizontal and vertical lines are mean values and the respective parallel interrupted lines, standard deviations of means.

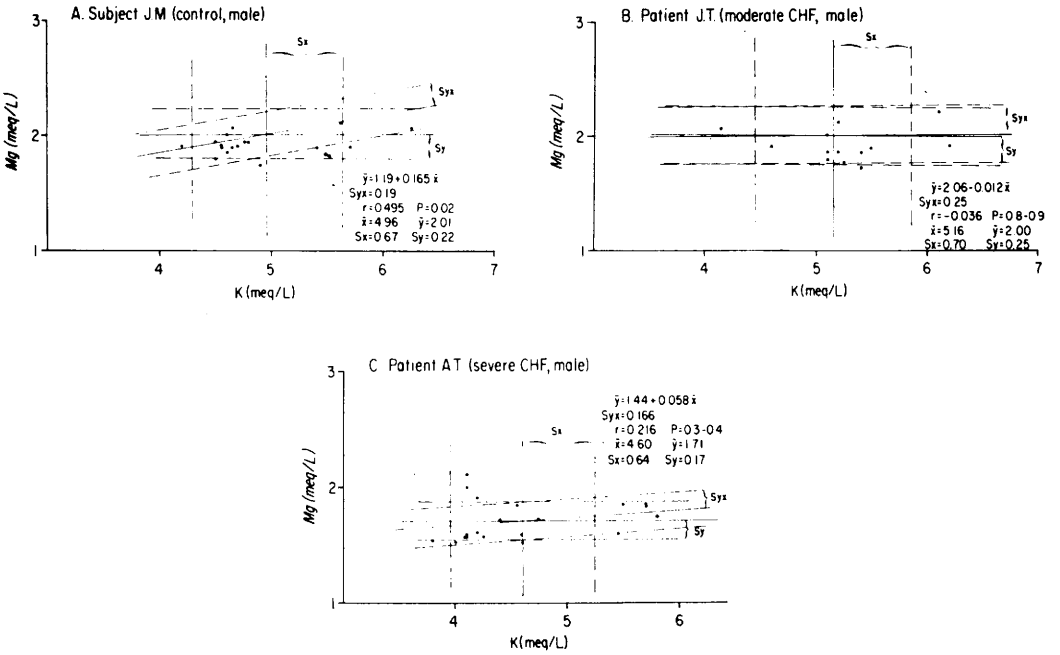

FIG. 2, A-C. Regression lines of relationship between daily plasma levels of Mg and K in one control subject and 2 patients with chronic congestive heart failure. See legend of Fig. 1 for representations of lines.

tivity resulting in diastolic arrest. On the other hand, the actions of these ions on the neuromuscular system are usually antagonistic. Magnesium has curare-like action(8), whereas potassium usually has an anticurare-like effect(9), although paresthesia of the extremities and even flaccid paralysis have been reported in patients with hyperkalemia (10). Therefore, it was considered of interest to study the relationship of the metabolic profiles of these two elements in patients with idiopathic cardiomyopathy and chronic congestive heart failure and in control subjects.

Materials and methods. Six subjects, 3 adult males from the U. S. Public Health Service Hospital in New Orleans and 3 adult females from the Charity Hospital in New Orleans were studied continuously for electrolyte balance for a period of one month under controlled metabolic conditions. Each hospital group consisted of one control subject and 2 patients with idiopathic cardiomyopathy and chronic congestive heart failure. The clinical data are shown in Table I. The diet for the 3 males contained approximately the following daily amounts of electrolytes: Na, 0.3 g; Cl, 1.5 g; K, 3.5 g; Mg, 0.3 g and Ca, 0.35 g. The diet for the 3 females contained: Na, 1.0 g; Cl, 1.5 g; K, 2.0 g; Mg, 0.25 g and Ca, 1.0 g daily. The actual intake of the electrolytes was calculated from the standard tables of foodstuffs. Blood samples, separately voided urine samples, 24-hour pooled urine and stool specimens were collected for chemical analyses for electrolytes. Mg and K were determined according to the method suggested by MacIntyre(11) except that acid digestion was used for the stool(12). Correlation coefficients of Mg and K for the daily cumulative balance, plasma level and renal clearance were calculated and the regression lines for each pair of variables were obtained by the method of least squares(13).

Results. Relationships between the daily cumulative balances of Mg and K: The correlation between the daily cumulative balance of Mg and K in the 6 subjects studied is shown in Fig. 1. There was a high, positive and significant correlation between these 2 variables in 4 of the 6 subjects, the correlation coefficients being higher than +0.97 with

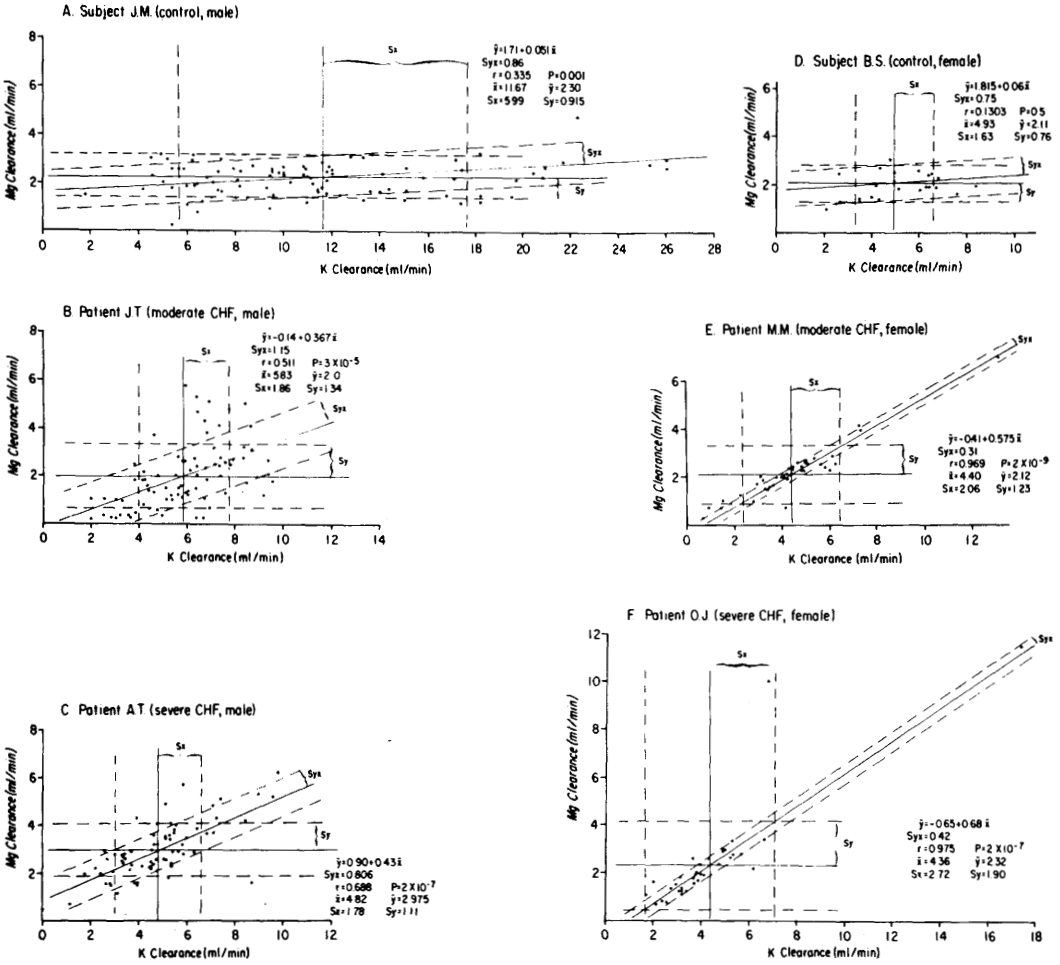

FIG. 3, A-F. Regression lines of relationship between renal clearances of Mg and K in 2 control subjects and 4 patients with chronic congestive heart failure. See legend of Fig. 1 for representations of lines.

p values less than 4×10^{-7}. The correlation coefficient for Patient MM (moderate congestive heart failure) was +0.5 with a p value of 0.006. For Patient AT with severe congestive heart failure, who died shortly after completion of the study, a negative correlation between the daily cumulative balance of Mg and K was obtained, the correlation coefficient being —0.6 with a p value of 0.006. The regression lines for the correlations and standard deviations in all 6 subjects are shown in Fig. 1.

Relationships between the plasma concentrations of Mg and K: The relationships between the plasma concentrations of Mg and K and their respective regression lines in the 3 male subjects are shown in Fig. 2. The statistical correlations were low and not significant, the correlation coefficients being 0.166 to 0.25 and the p values being 0.02 to 0.8 (Fig. 2). The relative variations (standard deviations as percentage of the means) were 13.5 to 13.9% for plasma concentration of Mg and 10 to 12.5% for plasma concentration of K during the observation period.

Relationships between renal clearances of Mg and K: The renal clearances of Mg for each separately voided and 24-hour pooled urine specimens were plotted against those for K as shown in Fig. 3. Both control subjects had low correlations between these two

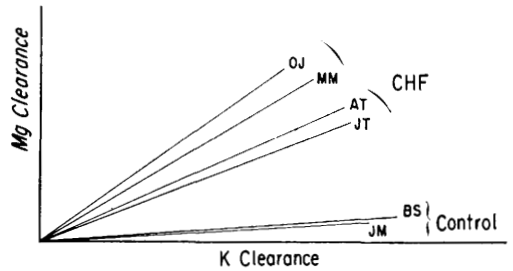

FIG. 4. Slopes of regression lines for renal clearances of Mg and K in 2 control subjects and 4 patients with chronic congestive heart failure.

variables, whereas all 4 patients with congestive heart failure had high and significant correlations. The correlation coefficients for the control subjects were 0.335 and 0.13 and those for patients with chronic congestive heart failure were 0.511, 0.688, 0.969 and 0.975 with p values less than 3×10^{-5} (Fig. 3). The slopes of the regression lines for all subjects are shown in Fig. 4.

Discussion. Daily cumulative balance reflects the overall conditions of metabolic balance for the body. In the 6 subjects studied, 5 exhibited high, positive and significant correlations between the daily cumulative balance of Mg and K. Similar relationships of these 2 ions in the diet (both ions were contained mainly in meat and vegetable) certainly contributed to the high correlation in the cumulative balance. Regulations in absorption and excretion must have been important in maintaining the high positive relationship. The physiologic significance of the relationships is further evidenced by the fact that Patient AT who had a negative correlation between these two profiles died shortly after completion of the study.

Both plasma concentrations of Mg and K were within normal ranges in all subjects studied. The relative variations from the means of the daily plasma levels were less than 15%. The relatively stable plasma levels of Mg and K probably tended to minimize the linear correlation between these two variables. Nevertheless, it is quite clear that neither plasma levels of Mg and K nor the correlation of these two variables reveal the pathophysiologic significance of these ions.

Decrease in urinary excretion of K following parenteral administration of $MgSO_4$ has been reported by others(14,15) and competition for renal tubular secretion of Mg and K was suggested(14). However, in this study, none of the 6 subjects had a negative correlation between the renal clearances of Mg and K. Correlation between the renal clearances of Mg and K was very low in the control subjects but quite high in the patients with congestive heart failure. The underlying mechanism is not known. Plasma levels of Mg and K were quite constant for all the subjects and, therefore, so must be the concentrations of Mg and K in the glomerular filtrate. The relationship of the slopes of the regression lines for the renal clearances of Mg and K as shown in Fig. 4 suggests that the renal tubular activity, either reabsorption or secretion or both, is in favor of greater Mg excretion than K excretion in the patients with congestive heart failure than in the control subjects.

Summary. The relationship between Mg and K was studied for 3 metabolic profiles observed simultaneously in 2 control subjects and 4 patients with idiopathic cardiomyopathy and chronic congestive heart failure under controlled metabolic conditions. The correlation between the daily cumulative balances of Mg and K was high, positive and statistically significant in all subjects except one patient with severe chronic congestive heart failure. The pathophysiologic significance of the correlations was discussed. The correlation between the plasma concentrations of Mg and K was neither high nor significant. The correlation between the renal clearances of Mg and K was high and statistically significant in the patients with chronic congestive heart failure but low in the control subjects. The underlying mechanisms are not fully understood.

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Effect of X-Rays on Hemolysin Plaque Forming Cells.* (30460)

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The effect of X-irradiation on the production of serum hemolysin levels has been studied by many investigators and was recently reviewed by Taliaferro *et al*(1). These studies have demonstrated the enhancing and depressing effects of X-rays on serum antibody titers(1-3). They have shown that the changes brought about by radiation are related to timing of radiation, antigen dose, radiation dose and species involved. Some insight into the effects of radiation on antibody response might be gained from an analysis of the antibody-forming cells. A recent hemolysin agar plaque technic described by Jerne and coworkers(4) provides a method for enumerating the hemolysin plaque forming cells in a heterogeneous cell population, such as spleen tissue. This report deals with the dose effect of X-ray administered at various times before and after antigen injection. The number of plaque forming cells of the spleen was correlated with serum hemolysin titers and with spleen indices (mg of spleen/g of body weight).

Materials and methods. Male LAF (C57L $\times$ A/He) mice, approximately 3 to 4 months of age, were given a single intraperitoneal injection of 8×10^8 sheep red cells. Animals were sacrificed 5 days after antigen injection. Spleens were removed and immersed in Eagle's medium without serum(5). Cells were separated from connective tissue stroma by compressing the tissue against the sides of a Dounce homogenizer with the loose fitting pestle. The cell suspension was then passed through nylon mesh bolting. Cell density was adjusted so that 0.1 ml of suspension contained one million cells. The plating technique was done according to Jerne *et al*(4). Serum hemolysin titers were assayed as described by Kabat and Meyers(6).

Results and discussion. Our studies indicated that hemolysin plaque forming cells in LAF mice spleens reached their peak 5 days after the mice received a primary intraperitoneal injection of 8×10^8 sheep red cells. The schedule for whole body X-irradiation, administered either before or after sheep red cell injection is outlined in Fig. 1. Data from these experiments are summarized in Table I. Four to 9 animals were used in each group.

Animals which had been irradiated with 500 R of X-ray all showed a pronounced decrease in spleen indices, in hemolysin plaques per million spleen cells, and in hemolysin plaques per total spleen. Animals irradiated at 3 days post-antigen injection were the least sensitive at this X-ray dose.

Mice receiving 250 R showed a varied response. Animals irradiated one day prior to or 3 days after sheep red cell injection showed a statistically significant (the level

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