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THE UNIVERSITY OF ALBERTA

INVESTIGATIONS ON THE NUTRITIONAL CARE OF DIALYSIS PATIENTS

BY

© JANIE LOUISE SANDERSON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

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Janie L Sanderson

81 Yorkleigh Ave.
Weston, Ontario
M9P 1Y3

Date: July 25 1986

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Investigations on the Nutritional Care of Maintenance Dialysis Patients" submitted by Janie Louise Sanderson in partial fulfilment of the requirements for the degree of Master of Science in Nutrition.

Margaret A. Gee
Supervisor

R Allen

J. J. Hawrysh

Date July 25, 1986

ABSTRACT

A survey of 46 kidney patients undergoing dialysis [30 continuous ambulatory peritoneal dialysis (CAPD) and 16 hemodialysis (HEMO)] was conducted to obtain information about nutrient intake and biochemical and clinical parameters. Twelve of these patients participated in a nine-month study to determine whether elevated blood lipid levels can be effectively lowered by dietary means.

The survey revealed that energy intake was less than 25 kcal/kg body weight for 38% of CAPD and 50% of HEMO patients. Protein intake was less than one gram per kg for 55% of CAPD and 44% of HEMO patients. Protein-energy malnutrition was diagnosed in 19% of males and 26% of females in the survey. The intake of many nutrients would appear to be inadequate according to the basic requirements known, especially calcium, folacin, zinc, vitamin A, ascorbic acid and thiamin. Some dietary deficiencies are corrected by the use of supplements but there would appear to be a need to improve the overall quality of dietary intake.

The effects of dietary modification were studied on 12 patients (six males and six females) using two diets: a fat-modified diet and fiber- and fat-modified diet. The entire study was of nine months duration. During the first three-month period, the patients' usual diets were

monitored and serum lipids evaluated. During the second three-month period, the patients followed a fat-modified diet under the supervision of a dietitian. The dietary intakes showed that patients consumed approximately 36% of kilocalories as fat, 48% as carbohydrate and 16% as protein. The quality of fat intake was modified as follows: polyunsaturated fatty acid/saturated fatty acid ratio (P/S) was 1.5 ± 0.5, significantly higher ($p < 0.001$), and mean dietary cholesterol intake was 215 ± 79, significantly lower ($p < 0.05$) than the baseline period. During the third three-month period the patients followed a combined fiber- and fat-modified diet. The dietary intakes showed that patients consumed approximately 37% of kilocalories as fat, 46% as carbohydrate, 17% as protein and 215 mg cholesterol per day and that the P/S ratio was 1.7. The quality of carbohydrate intake was modified as follows: mean dietary fiber intake was 24 ± 7 g per day, significantly higher ($p < 0.01$) than the fiber intake of the fat-modified diet period. The increased fiber came from cereals, including oat bran, whole grain breads, fruits and vegetables. During the six months of dietary treatment both fasting serum triglyceride levels and fasting total cholesterol (total-C) levels fell significantly ($p < 0.05$; $p < 0.01$) from the levels of the baseline period. There were also significant reductions in VLDL-cholesterol (VLDL-C) and LDL-cholesterol (LDL-C) ($p < 0.05$) with no change in HDL-cholesterol (HDL-C)

levels.

The major lipid-lowering effect occurred during period I on the fat-modified diet. The following serum lipid levels decreased significantly during period I: triglycerides ($p < 0.05$), total-C ($p < 0.01$), LDL-C ($p < 0.05$), and for the men VLDL-C ($p < 0.05$). During period II the serum lipid levels of period I were maintained with a further decrease in serum triglyceride for the males ($p < 0.05$). Both ratios LDL-C/HDL-C and total-C/HDL-C decreased by 5 and 9% respectively. The principal finding was that serum triglycerides decreased by 26% during period I and by 31% at the end of the study; VLDL-C levels decreased by 25% during period I and by 29% at the end of the study.

No correlation was found between lipid levels and fat components of the diet, probably due to the marked difference in individual responses. However, there were consistent negative correlations between dietary fiber and serum triglyceride levels and VLDL-C levels ($p < 0.01$; $p < 0.01$). In addition, there was a consistent negative correlation between dietary starch and serum cholesterol levels ($p < 0.01$). There was a consistent positive correlation between total kilocalorie intake and HDL-C levels ($p < 0.01$). Average weight loss was less than 4 kg for the entire study. However, for some patients there were frequent illnesses, including peritonitis and surgery.

There was a general improvement in serum creatinine levels during the study; serum creatinine decreased significantly during period II ($p < 0.05$) Correlations were found between serum creatinine and LDL-C ($p < 0.01$) and % risk of dietary folacin deficiency ($p < 0.01$). Consistent positive correlations were also found between serum phosphorus levels and LDL-C ($p < 0.001$) and total-C levels ($p < 0.01$).

Dietary intakes expressed as nutrient density revealed an improvement in overall diet quality by dietary intervention. The improvement in quality of intake was most noticeable for folacin, zinc, thiamin and fiber. A consistent positive correlation was found between % risk of dietary zinc deficiency and serum triglyceride levels ($p < 0.01$); a consistent negative correlation was found between the % risk of dietary folacin deficiency and HDL-C levels ($p < 0.01$). Energy and protein intake also improved throughout the study but some of the patients did not reach desirable levels. A consistent positive correlation was found between hemoglobin levels and dietary protein intake ($p < 0.01$).

We conclude that elevated blood lipids of patients undergoing dialysis can be reduced by modifying the quality of fat and carbohydrate in the diet. The dietary modifications we tested were practical and acceptable. Dietary modification can be of benefit to the patient

undergoing dialysis and can result in improvement in nutritional status and health.

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INTRODUCTION

Patients undergoing maintenance dialysis experience many nutritional problems. The reasons for these are diverse: impaired food intake, intake of medications, removal of nutrients or excessive uptake of nutrients such as trace elements during dialysis, impaired metabolic activity of the kidney resulting in reduced degradation of hormones and other peptides, impaired synthesis and degradation of amino acids, decreased renal clearance of urea and other products of metabolism, altered metabolism of nutrients, decreased intestinal absorption of nutrients such as calcium, impaired renal production of essential compounds such as the active form of vitamin D, hormonal disturbances such as hyperparathyroidism and insulin resistance and impaired renal ability to conserve nutrients. To date, interest in the diet of kidney patients has focussed on the maintenance of protein, phosphorus, sodium and water balance. However, many other nutrients have a role in the long-term prognosis of these patients. For example, those undergoing regular dialysis often develop hypertriglyceridemia. Little is known about the role of dietary intake in this phenomenon, but it is worthy of investigation since cardiovascular disease accounts for a significant number of deaths in maintenance

dialysis patients. We undertook the following investigations to survey the nutritional status of a group of dialysis patients and to determine the effectiveness of dietary manipulation in reducing elevated blood lipid levels.

INVESTIGATIONS

ON THE NUTRITIONAL CARE

OF MAINTENANCE DIALYSIS PATIENTS

LITERATURE REVIEW

When dialysis is substituted for normal kidney function the patient must adjust intake to maintain biochemical homeostasis. The planning of a diet for a patient undergoing maintenance dialysis focuses on the quantity of protein, sodium, potassium and fluid that can be balanced by combined "natural" and "artificial" kidney function. The criteria for judging the diet is the degree of biochemical control achieved. However, it is important that the diet not only curtail the accumulation of waste products between dialysis but also meet the nutritional needs of the patient. Renal failure has a profound effect on nutritional homeostasis. The unique characteristics of renal failure that have an impact on the metabolism of nutrients include:

- retention of nitrogenous waste products (e.g. urea, guanidines)
- impaired ability to excrete nutrients (sodium, potassium, phosphorus, magnesium, water)
- impaired ability to conserve nutrients (sodium, protein)
- impaired metabolic activity of the kidney (impaired synthesis and degradation of amino

acids; reduced degradation of hormones)

- impaired production of essential compounds (active vitamin D, red blood cells)
- decreased intestinal absorption of nutrients (calcium)
- altered metabolism of nutrients in other tissues (increased metabolic clearance of pyridoxine)
- endocrine disturbances (hyperparathyroidism affecting calcium and phosphorus metabolism; insulin resistance affecting glucose metabolism

(Kopple 1983)

Uremia is the condition associated with the accumulation of nitrogenous metabolites in the serum. It is characterized by gastrointestinal symptoms, neuromuscular symptoms and finally terminal coma. Serum urea nitrogen levels are elevated. A more accurate assessment of renal function is the serum creatinine level or the urinary creatinine clearance. These values are relatively uninfluenced by dietary protein (Dosseter 1966).

Hemodialysis, using an artificial kidney or dialyzer to remove undesirable materials from the blood, is now a common treatment for patients with end-stage renal disease and is usually performed three times per week (Massry, Sellers, 1976). The continuous ambulatory peritoneal dialysis (CAPD) procedure utilizes the patient's membranes

of the peritoneal cavity as the dialytic membrane rather than a dialysis machine. The dialysate enters the peritoneal cavity; most patients exchange four two-liter bags of dialysate a day for seven days a week (Popovich, 1978). CAPD has been in use since 1976.

Dietary Management

The basic goal of treatment is to minimize uremic symptoms and complications while maintaining good nutritional status.

Protein intake should be controlled so that the end products of protein metabolism do not accumulate in the body but adequate enough to prevent the development of negative protein balance. There are only a few studies of protein requirements for patients undergoing maintenance dialysis (Ginn 1968, Kopple 1969a, Borah 1978, Kluthe 1978). Current recommendations are 1.2 to 1.5 grams protein per kg body weight for CAPD patients and 1.0 to 1.2 grams protein per kg body weight for hemodialysis (HEMO) patients (Kopple 1984). Protein intake for the patient undergoing CAPD is more generous because of the high rate of protein loss into the dialysate. Protein loss during CAPD is estimated to be 5 to 20 grams per day (Moncrief 1979). Little protein is lost during hemodialysis but there are losses of amino acids and peptides amounting to 8 to 10 grams amino acids and 3 to 4

grams of peptides per dialysis (Kopple 1984).

For the kidney patient, meeting protein needs really means meeting the needs for essential amino acids. It is important to note that at present, the minimum requirements of essential amino acids for uremic patients are not known. In addition to the eight essential amino acids for healthy adults, histidine has been found to be essential for uremic patients. Bergstrom (1972) found that nitrogen balance and plasma urea levels improved with the addition of histidine. Reduced plasma histidine in uremic patients may be related to hematologic changes; supplementation with histidine has been shown to result in increased hematocrit and decreased reticulocytes (Giordano 1973).

Aberrations in serum amino acid profile, with decreased essential amino acids and increased non-essential amino acids have also been found. For example, the tyrosine-phenylalanine ratio is reduced, suggesting diminished activity of phenylalanine hydroxylase, which functions in the formation of tyrosine from phenylalanine. At the same time, other metabolites of phenylalanine are increased. The cause or significance of these metabolic alterations is unknown. Current recommendations stipulate that at least 50 per cent of the dietary protein be of high biological value to provide a good assortment of essential amino acids (Kopple 1984). When the amino acid supply is inadequate to maintain

nitrogen balance, degradation of endogenous protein will occur and waste products will accumulate.

Not only is it necessary to supply adequate essential amino acids but energy needs must also be met. Protein cannot fulfill its nutritive function unless adequate energy is supplied (Calloway 1954, Elwyn 1979). It has been found that nitrogen balance improves in patients with renal failure maintained on very low protein diets if energy intake is increased (Hyne 1972, Bergstrom 1975). Poor energy intake has been identified as a factor contributing to poor growth of uremic children (Simmons 1971).

For the dialysis patient, sodium intake is adjusted to prevent sodium retention or sodium deficiency. The accumulation of sodium between dialysis treatments may result in extracellular overhydration, hypertension, edema and congestive heart failure. Sodium intake is restricted to the amount that limits weight gain between dialysis runs, usually about two to four grams per day.

A high blood potassium level (hyperkalemia), is a common problem in the final stages of renal failure so patients are instructed to avoid potassium-rich foods, including many fruits and vegetables. There are few clinical symptoms of hyperkalemia; the major effect is serious cardiac disturbances, best shown by the electrocardiogram.

Maintaining fluid balance in the patient is extremely

important because fluid overload can result in the appearance of edema, congestive heart failure, hypertension or hyponatremia. Body weight and blood pressure are monitored closely and used as indicators of fluid retention. Fluid may be limited to 500 to 1500 mL per day (Kopple 1984). In the case of the patient undergoing CAPD, the glucose content of the dialysate may be increased to remove more fluid (as a result of the higher osmotic effect).

In addition, the control of serum phosphorus concentration toward normal is an important aspect of patient management. Phosphorus, an end-product of protein metabolism, accumulates in the blood of renal failure patients. Marked hyperphosphatemia is harmful as it enhances soft tissue calcification and indirectly stimulates parathyroid hormone secretion. Massry (1977) has suggested that many of the manifestations of end-stage renal failure are a consequence of hyperparathyroidism. The control of serum phosphate and calcium levels has generally been achieved by the use of phosphate binders, calcium supplements (dietary restriction of milk and dairy products to control phosphate intake may create a dietary calcium deficiency) and vitamin D derivatives (Schoolworth 1975, Kopple 1984). There are some problems that arise as side effects of phosphate binders. Aluminum has been found to be elevated in tissues of patients receiving aluminum hydroxide or aluminum carbonate phosphate

binders. Aluminum may also be derived from water used in dialysis. It has been suggested that accumulation of aluminum in the brain may be related to "dialysis dementia" sometimes seen in dialysis patients (Thomson 1983). A second problem consequent to the intake of phosphate binders is the occurrence of severe constipation and nausea.

Water soluble vitamins are lost during dialysis and patients become deficient if they are not given replacements. Current recommendations are; 1 mg folacin, 10 mg vitamin B_6, 100 mg ascorbic acid and recommended dietary allowances of other water-soluble vitamins (Kopple 1984). There is some evidence of changes in pyridoxine metabolism and an increased need for this vitamin. The etiology of the increased requirement has been attributed to increased clearance of pyridoxal phosphate (Spannuth 1976), action of circulating inhibitors, and drug related impaired absorption (Raskin 1965).

Very little work has been done to elucidate the micronutrient status of renal patients. A few reports indicate that some renal patients have abnormally low blood zinc levels and it has been suggested that an impaired sense of taste in renal patients be treated with zinc supplements (Atkin 1978). It is important that the patient undergoing maintenance dialysis have an adequate diet to curtail the development of malnutrition.

Special Problems

Malnutrition

Many reports indicate that malnutrition occurs in patients undergoing maintenance dialysis (Kopple 1978a, Bianchi 1978, Kluthe 1978, Attman 1980, Blumenkrantz 1980, Guarnieri 1980, Bansal 1980, Thunberg 1981, Young 1982, Wolfson 1982). Bansal, in 52 HEMO patients, found a 19 per cent incidence of protein-energy malnutrition (PEM) based on anthropometric, biochemical and immunological data. Other reports indicate an incidence of PEM that is similar or higher. Poor dietary intake is believed to be one of the major causes of wasting. Several factors may contribute to the consumption of an inadequate diet including altered appetite from accumulation of toxic substances, altered taste perception (Burge 1979), inadequate dialysis, gastrointestinal symptoms, high energy requirements that are difficult to meet (e.g. with peritonitis) (Kopple, 1983). In addition, regular dialysis treatment imposes nutritional losses (amino acids, vitamins and other bioactive compounds such as carnitine). The patient undergoing CAPD may be particularly vulnerable to malnutrition because of the high rate of protein loss into the dialysate. With acute illness, such as peritonitis, protein losses may be very high due to increased peritoneal protein permeability

(Grodstein 1981). Steinhauer (1986) reported that the loss of protein increased from 8.4 grams per day to 17.5 grams on the first day of peritonitis. One report indicated that protein loss during CAPD was decreased if amino acids were added to the dialyzing fluid [10 mL of an intravenous amino acid preparation (Vamin) to each liter of dialysis fluid] (Greenfield 1977).

In addition to poor dietary intake, other factors contribute to malnutrition: blood loss, minor illnesses, derangements in metabolism. According to some researchers, catabolic body wasting is a phenomenon associated with renal failure (Garber 1978, Mitch 1978). Mitch has suggested that the insulin resistance of renal failure contributes to the net catabolism of muscle. In rats with experimental renal insufficiency there is resistance to the anabolic effects of insulin on muscle protein synthesis (Garber 1978, Mitch 1981). Maillet and Garber (1980) found that there is increased synthesis and release of alanine and glutamine from skeletal muscle contributing to increased gluconeogenesis, degradation of skeletal muscle and the wasting syndrome.

Some studies suggest that protein malnutrition may lead to deficiencies of zinc and possibly other trace elements. Patients treated by dietary protein restriction were found to have low zinc concentration in plasma, leukocytes and hair compared to that of age and sex-matched controls (Mahajan 1979). Zinc deficiency and

decreased taste acuity were detected in two of three dialysis units in Toronto (Blendis 1981). Protein intak differed markedly between the three units and zinc levels could be correlated with dietary protein.

Zinc is a trace element essential for the human, its metabolic role encompasses many pathways including protein and nucleic acid pathways. Zinc has been found to have a profound effect on the metabolism of cholesterol; zinc depletion results in abnormal serum levels of cholesterol and lipoproteins (Petering 1977). In zinc-deficient rats Koo (1981) found a selective decrease in HDL-cholesterol. Recently Koo (1986) has shown that zinc deficiency in rats results in molecular alterations of chylomicrons and a significant delay in the plasma clearance and hepatic uptake of chylomicron cholesterol. Koo suggests that with zinc deficiency the apoprotein makeup of chylomicrons may be altered as well as the size and shape of the chylomicrons.

Evaluation of the dietary intake of zinc must take into consideration its bioavailability. The amount of zinc in the diet may not be related to zinc status because zinc sometimes has low availability (Rosenberg 1982). Interactions between nutrients can alter their availablilty with the result that a seemingly adequate intake may not meet the needs. The bioavailability of zinc and many trace elements is susceptible to alterations by dietary factors and by changes in gastrointestinal

physiology. Zinc cations can form complexes in the intestine which can either reduce or increase absorbability of the element (Sandstrom 1980). For example, iron and zinc appear to compete for absorption channels in the intestine (Solomons 1983). Recently it has been reported (Gishan 1986) that there is mutual inhibition between folacin and zinc at the site of intestinal transport. We must therefore, be cautious about creating nutrient imbalances with vitamin-mineral supplements.

Energy intake

Sufficient calories must be supplied to spare protein, that is, to prevent the use of dietary protein to supply energy needs. Patients undergoing maintenance dialysis tend to ingest about 25 to 35 kcal/kg even when they are strongly encouraged to increase caloric intake (Kopple 1983). Unfortunately there is little information regarding the energy requirement of patients with renal failure. Some researchers have suggested that increasing energy intake to 40 or 50 kilocalories per kg per day may improve nitrogen balance (Hyne 1972). However, it is currently recommended that patients receive at least 35 kcal/kg/day similar to recommendations for the population in general (Kopple 1986).

Recently Carvounis et al (1986) have reported a longitudinal study of 43 hemodialysis patients and state that their patients apparently had better caloric intakes than reported for many other studies. Some of the contributing factors they list include less frequent use of hypotensive drugs and better efficiency of dialysis. They insist on careful control of sodium and water intake and normalizing blood pressure simply by fluid removal without using antihypertensives. They report that when hypotensives are used, dialysis may be less effective because of hypotensive episodes and decreased flow and decreased fluid removal during dialysis. In addition, the patient may be nauseous both during and following dialysis.

Assessment of nutritional status

Clinical observations may be insensitive for detecting nutritional problems of the kidney patient. For example, body weight may be a deceptive criterion in dialysis patients since their total body water can be expanded even in the absence of edema. Serum albumin levels may be a good guide to nitrogen balance but these levels may remain normal even when considerable protein depletion occurs (Blumenkrantz 1980, Coles 1979).

Dietary data must be collected to evaluate the capabilities for improvement of nutritional status.

Unfortunately, the assessment of dietary intake is frought with difficulties (Marr 1971). All dietary assessment techniques used on free-living individuals rely on information supplied by the subjects themselves. Methods used with individuals include the following:

- an estimation by recall in which the subject recalls the food intake over the previous 24 hours or longer
- records of food eaten by an individual kept by weights, household measurements or by estimated quantities over a stated period of time

The skill of a dietitian assists in acquiring reliable dietary data. According to Burke (1947) "the interviewer must have a sound basic training in nutrition and the allied sciences and needs to be familiar in a thoroughly practical manner with food values and with the eating habits of the group... it should be possible to conduct the interview in such a manner as not to suggest an answer." The 24-hour recall method, used in the Nutrition Canada survey was a carefully standardized method using dietitians to conduct the interviews. The dietitian asked each subject for an account of all food items consumed throughout the day in chronological order.

Poor estimation of serving portions and incomplete collection of data are the major sources of error in dietary assessment methodology. Food models, representing known volumes were used in the Nutrition Canada

methodology for the estimation of portion size. Probing by the dietitian minimizes errors of omission.

The choice of an appropriate assessment technique is important. The objectives of the dietary study will determine the appropriate methods to be used in collecting, processing and interpreting the dietary data (Young 1981, Stuff 1983). Dietary data on individuals are collected to obtain:

1. average nutrient intake of groups for comparison with other groups
2. nutrient intake of a given individual for correlation with biochemical or clinical measurements obtained on that individual.

The recall method of assessing dietary intake is suitable for the classification of intakes in the survey of a group (Young 1981). The 24-hour recall is often used for surveys. Memory for recalls limited to 24 hours appears quite good and the response rate is usually high. Some studies indicate that the recall is prone to over-report low intakes and under-report high intakes (Gersovitz 1978).

For the correlation of dietary intake to the levels of substances measured in the blood, the assessment technique must give a reasonable estimate of the usual dietary intake over an extended period. Repeated 24-hour recalls over a substantial period can be used (Garn 1976) or diet records can be used. Seven-day records have

frequently been used. Diet records require considerable participant cooperation and interviewer time. Schnakenberg (1981) has suggested that the diary-interview technique is a reliable method of collecting dietary data. One of the problems in many estimated records is the inability of subjects to estimate portion sizes of food accurately, particularly certain types of food such as meat (Young 1953).

There is no agreement on the number of days required to accurately assess quantities of nutrients consumed. The variation in the nutrient intake from day to day depends to some extent on the distribution of nutrients in foods. Variation is least for nutrients with wide distribution, such as calories, protein, iron, thiamin and niacin. Extreme differences in vitamin A, especially carotene, result in large daily variations (Beaton 1983). Flores (1962) considered six days to be the minimum period of time for adequate evaluation. Schnakenberg et al (1981) concluded seven or eight-day diet records should be adequate to obtain a reliable sample of an individual's eating pattern and food selection habits but short enough to maintain a cooperative attitude in most of the participants. Chalmers (1952) concluded that data within 95% confidence limits could be obtained from 15 days of intake records for men and 12 days for women. Recently Beaton (1983) emphasized the impact of individual variation in one person's intake. Houser and

Bebb (1981) suggested that a representative food intake must include both week days and week-end days. Unfortunately there is no absolute method of dietary assessment guaranteed to give a picture of usual food intake, either in the present or in the past. Beaton (1983) has urged that in designing nutritional studies, careful consideration be given to the intended use of the data and the precise nature of the information needed.

The interpretation of nutrient intake data is also very difficult. The selection of a standard for rating of calculated nutrient intakes has often been arbitrary. Recommended dietary allowances for the general population are often used because individual requirements for nutrients cannot be readily determined. However, recommended allowances are designed with a margin of safety above average physiological requirements to cover variations among essentially all healthy individuals. The margins of safety are more generous for some nutrients than for others. A major difficulty in using recommended allowances in the assessment of dietary information is that they are not uniformly related to minimal needs. It should also be kept in mind that although the recommended dietary allowances may be generous for the healthy individual they may not be for those with chronic diseases. For many diseases nutrient needs exceed those of the normal individual and intake of the usual recommended dietary allowance may not be sufficient.

Anderson et al (1982) recently developed a method for interpreting dietary data using a statistical approach. The lower the intake is in relation to the recommended allowance, the greater is the likelihood that it is inadequate to meet the individual's actual requirement. By examining the distribution of the data, the number of individuals in a group who are truly deficient can be predicted. The proportion of inadequate intakes estimated by this method has been shown to correlate with the prevalence of biochemical and clinical indications of inadequacy.

Hyperlipidemia

Cardiovascular disease is the most common cause of death among renal failure patients undergoing dialysis (Brunner 1978). Lindner et al (1974) found that the incidence of ischemic heart disease and strokes among dialysis patients were significantly raised compared with age and sex-matched non-renal controls. Lipid abnormalities in patients with renal failure have been well documented (Brunzell 1977, Chan 1981, Ibels 1975, Norbeck 1981). The most often reported abnormality in blood lipids is elevated triglyceride levels. The hyperlipidemia and cardiovascular disease of renal failure does not respond to hemodialysis (Daubresse 1976, McCask 1975, Hussey 1976). Whether or not the lipid

abnormalities contribute significantly to the atherosclerotic lesions that develop frequently in these patients is currently under debate (Laskar 1979, Pierides 1975, Nicholls 1980, Rostand 1979, Vincenti 1980). Certainly dialysis patients have a variety of medical complications, any of which are risk factors for the premature development of atherosclerosis, including the following: hyperlipidemia, hypertension, abnormalities in carbohydrate metabolism, hyperparathyroidism and hyperuricemia.

High serum triglyceride levels occur frequently among patients undergoing dialysis (Lewis 1973, Gutman 1973, Moncrief 1979, Cattran 1976, Bagdade 1968, Blumenkrantz 1976). The etiology of the hypertriglyceridemia is probably multifactorial. A decreased triglyceride clearance from the plasma appears to be an important factor (Lee 1978, Cramp 1975). After an oral fat load, peak post-prandial triglyceride levels are higher and remain elevated longer than they do in hypertriglyceridemic non-uremic subjects (Chan 1981). This occurs despite the delay in fat absorption characteristic of most renal failure patients (Drucker 1982). The clearance of triglyceride from the plasma depends on the enzyme lipoprotein lipase; decreased activity of lipoprotein lipase and also hepatic lipase have been found in renal failure (Goldberg 1979, Norbeck 1981). It as possible that there is loss of a cofactor

for lipoprotein lipase in the dialysate (Lees 1982, Chan 1981). With dialysis, there is also loss of carnitine, a factor necessary for the transport of fatty acids into the mitochondria for oxidation (Bohmer 1978).

Another factor contributing to elevated triglyceride levels is excessive hepatic synthesis of triglyceride (Lee 1978, Cramp 1975, Attman 1979). This factor may be particularly important for CAPD patients because the constant absorption of glucose from the peritoneum invariably raises insulin secretion (Berger 1978, Grodstein 1981, Nolph 1980, Oreopoulos 1979). Insulin may modify tyiglyceride metabolism in at least three ways: by enhancing triglyceride synthesis in the liver, by decreasing release of fatty acids from adipose tissue and by modifying the availability of lipoprotein lipase. In fact, renal failure is characterized by high circulating insulin levels and peripheral insensitivity to insulin (Dzurik 1969, De Fronzo 1980, Lowrie 1970). Lee (1978) considers that for all patients with renal failure, high levels of dietary carbohydrate contribute to the hypertriglyceridemia because patients are encouraged to use high carbohydrate energy sources. Cramp (1975) also considered an additional factor of stimulation of hepatic triglyceride synthesis from free fatty acids released from tissue triglyceride stores due to abnormal increase in growth hormone resulting from glucose intolerance and protein malnutrition.

Several other factors probably contribute to the development of hypertriglyceridemia including: a defect in the protein fraction of the lipoproteins which is a major activator of lipoprotein lipase (Rapoport 1978), occupation of albumin binding sites for triglyceride by other molecules accumulating in uremia (Lee 1978), and drug therapy such as antihypertensive medications (Bauer 1981, Joos 1980) , heparin (Applebaum-Bowden 1979) and androgen therapy (Lee 1978).

The relationship between blood lipid levels and atherosclerosis is ultimately related to the plasma lipoproteins (Fredrickson 1967abcde, Goldstein 1977). The lipoproteins, composed of protein, triglyceride, cholesterol and phospholipid are the vehicles for transporting insoluble lipids from their site of origin to their site of utilization. The lipoproteins are macromolecules which vary in size, hydrated density and chemical composition. There are five classes of lipoproteins: chylomicrons, very-low-density lipoproteins (VLDLs), intermediate-density lipoproteins (IDLs), low-density lipoproteins (LDLs), and high-density lipoproteins (HDLs). In normal plasma of the fasting individual the approximate proportions of these lipoproteins is as follows: LDL 50%, VLDL 15%, HDL 35%.

Lipoprotein transport can be divided into two phases; the exogenous system transports the lipid obtained from the intestine either from the diet or recycled in the

enterohepatic circulation and the endogenous system transports the lipid synthesized in the liver (Brown 1981). In the body, lipoproteins form a dynamic system in which both exchange and net transfer of protein and lipid occur. Catabolism of lipoproteins within the circulation produces new lipoproteins altered in chemical composition and molecular properties. VLDL consists primarily of triglyceride derived endogenously from the liver, synthesized from various precursors such as fatty acids and carbohydrate. VLDLs transport endogenous triclyceride and are gradually converted into IDL and LDLs in a series of steps during which triglyceride is removed progressively by tissue lipoprotein lipase (Sigurdsson 1975, Goldstein 1977). The free cholesterol, phospholipid and apoprotein (apo-C) are transferred to HDL. The excess cholesterol that has been transferred to HDLs is esterified by the action of the enzyme lecithin-cholesterol acyl-transferase (LCAT) and then transferred back to the IDL (Glomset 1970). The lipid-free portions of lipoproteins, the apoproteins, function as lipid transport proteins and have unique lipid-binding properties and functions as cofactors for lipolytic enzymes. By interaction with enzymes and cell surface receptors, the apolipoproteins determine where each lipoprotein is metabolized.

The hyperlipidemias of renal failure are characterized by high levels of serum triglyceride and

VLDL and low levels of HDL (Cattran 1976). The frequent association of hypertriglyceridemia with hypercholesterolemia has presented difficulties in the clear identification of hypertriglyceridemia alone as an indicator of susceptability to premature cardiovascular disease. Carlson (1972), however, has correlated hypertriglyceridemia with increased prevalence of cardiovascular disease. Elevated levels of serum triglyceride may predispose to acclerated cardiovascular disease especially if the lipoprotein molecules are fairly small in size. There is an accumulation of VLDL remnants of lipoprotein catabolism in patients treated by hemodialysis (Nestel 1982). The concentration of IDL is increased as is the total content of triglyceride and cholesterol in VLDL. The increased accumulation of IDL may be important in the pathogenesis of atherosclerosis (Tatami 1981). Patients treated by hemodialysis have high plasma concentrations of apolipoprotein A-IV indicating a greater contribution of lipoprotein-remnant particles from the gut than is usually present with hypertriglyceridemia (Nestel 1982). High levels of LDLs have been implicated in the pathogenesis of cardiovascular disease (Goldstein 1977, Brown 1984). Low HDL levels are recognized as possible predictors of cardiovascular disease and recent work is examining the importance of subfractions of HDLs (HDL_2 and HDL_3) (Miller 1975, 1979, Bagdade 1977).

The relationships between the major lipoproteins of

plasma is also of importance: a high LDL/HDL ratio has been associated with a tendency toward atherosclerosis (Lees 1982), as has a low ratio of LDL/total cholesterol (Gordon 1977).

Dietary management of hyperlipidemia

All components of the diet may affect blood lipid levels (Lewis 1976). In addition the individual effects of components can be modified by interactions between components. Lipid-lowering diets usually focus on the effects of total energy intake, the quantity and quality of fat and the quantity and quality of dietary carbohydrate (Havel 1982).

Excess caloric intake results in increased synthesis of triglyceride and cholesterol by the liver. Reducing caloric intake rapidly reduces VLDL triglyceride levels in obese individuals.

The major dietary components that influence plasma lipoprotein levels are saturated fatty acids and cholesterol (Connor 1982). The mechanisms by which each of these components influences lipoprotein levels remains uncertain. Saturated fatty acids raise serum cholesterol (Keys 1957b). Saturated fatty acids vary in their hypercholesterolemic effect with the C_{12} to C_{16} compounds (lauric, myristic, and palmitic acids) having the greatest effect. Stearic acid (C_{18}) has little influence on serum

cholesterol; however stearic and palmitic acids increase triglyceride levels. The fats in the diet may be divided into three classes according to the degree of saturation of their fatty acids: saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids. Polyunsaturated fatty acids lower serum cholesterol (Keys 1957b). Although polyunsaturated fatty acids lower serum cholesterol levels, the effect is less marked than that of saturated fatty acids in raising serum cholesterol; in equal concentrations polyunsaturated fatty acids (PUFA) lower cholesterol only half as much as saturated fatty acids raise it (Hegsted 1965, Keys 1957a). The most effective treatment for lowering elevated blood lipids combines decreases in saturated fat and dietary cholesterol intake with increased intakes of polyunsaturated fat. Critical limits of dietary fat composition for effective serum cholesterol reduction have been established (Brown 1966, 1971, Nestel 1975, Whyte 1976, Keys 1965ab, Grande 1972). Anderson (1976) states that the serum cholesterol lowering effects of decreased dietary cholesterol intake and increased PUFA intake may be independent of each other.

The PUFAs must be obtained from dietary sources and therefore are essential fatty acids. The PUFAs can be further subdivided into omega-6 and omega-3 fatty acids. Linoleic acid C_{18}, (two double bonds) and arachidonic acid (C_{20}, four double bonds) are the major examples of the

omega-6 type. Arachidonic acid is synthesized in the liver from linoleic acid. Omega-3 acids include linolenic acid (C_{18}, three double bonds) and eicosopentaenoic (C_{20}, five double bonds), found in fish oils. Both omega-3 and omega-6 fatty acids lower plasma cholesterol and LDL cholesterol levels. The omega-3 fatty acids lower plasma triglycerides, especially VLDLs (Bang 1971, 1980). The greater hypotriglyceridemic effect of omega-3 PUFAs has been verified in normal subjects and in patients and is believed to be due to an inhibition of VLDL synthesis in the liver, thereby depressing LDL synthesis (Hamazaki 4, Phillipson 1985). Monounsaturated fatty acids have a negligible effect on serum lipid levels (represented in foods almost solely by oleic acid). However, the use of monounsaturated fatty acids to replace some of the saturated fatty acids in the diet has recently been advocated. This can result in a substantial reduction in LDL-cholesterol (Mattson 1983).

Modifying the fat content of the diet (a P/S ratio of at least 1.0) has been found to reduce serum triglycerides as well as serum cholesterol levels (Chait 1974, Grundy 1975). The effect on triglycerides is possibly the result of reduced hepatic VLDL-triglyceride synthesis. Nestel and Barter (1971) infused labelled palmitic and linoleic acids into normal and hyperlipidemic subjects and calculated a greater proportion of palmitate turnover than of linoleate turnover was incorporated into plasma

triglyceride. They hypothesized that a diet rich in linoleate and poor in palmitate decreased the availability of free fatty acids as substrates for hepatic VLDL-triglyceride synthesis.

The amount and type of dietary carbohydrate influences serum lipid levels, especially triglyceride and VLDL levels. An increase in dietary carbohydrate may lead to increased fasting triglyceride concentration (Grundy 1982) owing mainly to increased hepatic secretion possibly secondary to hyperinsulinemia (Liu 1984). Although the elevation is usually transient in healthy persons, peaking in about a week (Nestel 1970), it may be permanent in susceptible persons (Reiser 1982, Kuo 1965). Simple sugars, especially sucrose, may increase VLDL levels disproportionately in hypertriglyceridemic individuals; and sugars may have a greater effect than starch (MacDonald 1964, Reiser 1979). Little (1970) concluded that sugar was only hyperlipidemic in the presence of saturated fatty acids and cholesterol. This may be because endogenously synthesized fats from carbohydrate sources consist of saturated and monounsaturated fatty acids. Unless the diet also contains sufficient PUFA to counteract these endogenous lipids there will be a rise in serum lipoprotein. The mechanisms leading to carbohydrate-induced lipidemia have not been clarified to date. The work to date, however, indicates that hypertriglyceridemic subjects demonstrate a marked

sensitivity to sugar in the diet. Bagdade (1970) suggested that in patients with uremic hypertriglyceridemia, increased hepatic production of VLDL-triglyceride was caused by a high intake of carbohydrate and raised insulin secretion. Sanfelippo (1978) showed that it was possible to lower plasma triglyceride levels in patients on hemodialysis by reducing carbohydrate intake. The low carbohydrate diet may have helped to restore insulin responsiveness since the plasma insulin peak after a meal was reduced with the lower carbohydrate diet.

The fiber content of foods also appears to be related to circulating lipid levels and atherogenesis. Absorption of the carbohydrate from foods rich in fiber results in a more sustained absorption by the gut and less widely fluctuating insulin and glucose levels than is the case with refined carbohydrate. Jenkins (1985) studied the effect in hyperlipidemic patients of substituting carbohydrate foods into their diets which cause lesser rises in blood glucose than more commonly eaten foods (pumpernickel bread, bulgur, barley, legumes). The diet resulted in a flattening of the post-prandial blood glucose rise and significant falls in both total and LDL-cholesterol. Serum triglyceride levels were also reduced and this reduction correlated with the increase in dietary fiber content of the diet. In this study the diets contained 16 and 25 grams dietary fiber and 48 to 50

per cent of Calories from carbohydrate. Albrink (1986) examined the effects of dietary sugar and fiber on blood lipid levels. The diets used contained levels of fiber of 14 and 34 grams per day and levels of sucrose of 0, 18, 36 and 52 per cent of Calories. The sources of fiber were All Bran, pinto beans, bread, fruits and vegetables. Fiber was found to exert a protective effect against carbohydrate-induced lipemia. Blood triglyceride levels increased with increasing amounts of sucrose in the diet; dietary fiber counteracted this effect. Both post-prandial and fasting triglyceride levels showed the same protective effect of fiber against sucrose-induced hypertriglyceridemia. Recently Rivellese at al (1985) used a high-fiber diet in treating diabetic patients with kidney failure. They found that the high-fiber diet improved blood glucose control and in addition, lowered serum creatinine levels. They hypothesized that a reduction of muscle protein catabolism was secondary to the improved insulin responsiveness.

The effect of dietary fiber on plasma lipoprotein levels has not been extensively explored. Animals on diets containing alfalfa (pectin and lignin), cellulose and cholestyramine were found to have significantly lower hepatic triglycerides and higher hepatic phospholipids (Vahouny 1980). Chen and Anderson (1979) found that feeding pectin, guar gum and oat bran to rats resulted in lower levels of serum triglyceride and cholesterol and in

higher levels of HDL cholesterol. Studies on humans are conflicting. The majority of studies report no effect of dietary fiber on plasma triglycerides (Kelsay 1978). A triglyceride-lowering effect was reported by Kay (1982), Albrink (1979) and Anderson (1980). Some workers have reported serum cholesterol reductions when dietary fiber intake was increased (Kay 1980, Anderson and Ward 1977). Dietary fiber constituents probably have many effects on the absorption and metabolism of cholesterol and triglycerides including: decreased lymphatic absorption, decreased intestinal transit time and binding of bile acids.

Lewis (1981) has suggested that the additive effects of various dietary modifications can produce marked blood lipid lowering effects. Lewis obtained a marked reduction in serum cholesterol levels using diets both modified in fat content and supplemented with fiber (fruits, grains, beans and vegetables). The fat modified diet supplemented with fiber contained 27% of energy from fat (P/S ratio of 1.0), 252 mg cholesterol and 55 g dietary fiber per 2500 kcal. Lewis suggested that the marked reduction in blood lipids could be attributed to the additive effects of two alterations (fat modification and increased fiber). The effects of both fat modification and fiber supplementation resulted in a fall in serum cholesterol of 24-29%, in LDL-cholesterol of 31-24% and in serum triglyceride of 21-26%.

In addition to Calories, fat and carbohydrate, many other dietary factors may affect blood lipids including alcohol, protein and zinc. Ingestion of alcohol increases plasma triglyceride levels. Like sucrose it is more obviously hyperlipidemic in the presence of a diet high in saturated fatty acids (Schlierf 1964). Sustained ingestion of alcohol is associated with increased HDL levels. For each ounce of alcohol ingested weekly, levels of HDL-cholesterol increased by 0.7 mg/dL (Havel 1982). Thus, the total intake must be considered when examining dietary factors which may contribute to or protect against cardiovascular disease.

The effect of diet therapy on elevated serum triglyceride levels of patients undergoing maintenance dialysis has been investigated on a few occasions. Cattran et al (1980) investigated the effect of altering the level of carbohydrate in the diet. Reducing the proportion of carbohydrate to 20% of Calories resulted in a decrease in the elevated triglyceride levels. However, the diet of conventional foods was high in fat and was poorly accepted. Sanfelippo and coworkers (1978) also showed that it was possible to lower plasma triglyceride levels in patients on hemodialysis by reducing dietary carbohydrate intake and increasing polyunsaturated fat intake. Sanfelippo et al used a liquid formula diet to achieve the desired dietary modification (P/S = 2). A similar result was obtained in a study of non-dialyzed

end-stage renal failure patients (Sanfelippo 1977).

Several workers have modified the quality of fat in the diet of patients on dialysis without reducing the total carbohydrate content of the diet. The results have been inconsistent with the majority achieving a lowering of blood triglyceride levels (Gokal 1978ab, Cianconi 1978, Walquist 1977). Wass (1981) reported an effect on LDL cholesterol and total cholesterol levels but no effect on VLDL-cholesterol or triglyceride levels. In this case the P/S ratio was 1.0; Gokal et al used a P/S ratio of 2.0. In one study on non-dialyzed patients a P/S ratio of 4.2 in the diet resulted in a 28% reduction in triglyceride concentration (Tsukamoto 1982). Ritz et al (1985) expressed concern about the poor long-term palatability and acceptability of lipid lowering diets and stated that dialyzed patients are frequently anorectic and may easily become malnourished on such diets.

Clofibrate is a drug that is often effective in treating hypertriglyceridemia. This however, is not the therapeutic measure of choice for the patient with renal failure because its active component is excreted by the kidneys and an accumulative overdose can easily occur. Diet therapy is the treatment of choice when there is concern about the side effects of drug therapy.

A very important part of the treatment of lipid abnormalities is an exercise program. Goldberg (1980) reported that an exercise program for hemodialysis

patients resulted in a 39% decrease in plasma triglycerides and a 23% increase in HDL-cholesterol. The lipid levels returned to baseline levels when the exercise program stopped. However, exercise benefits the dialysis patient in many ways including; an improvement in glucose tolerance, a decrease in the severity of anemia and a decreased requirement for antihypertensive medications (Zabetakis 1982, Goldberg 1980).

In conclusion, little is known about the effect of diet therapy on blood lipid levels of patients undergoing dialysis. The following studies were designed with the following objectives:

1. to survey the dietary intake of patients on dialysis
2. to determine the effects of the following dietary modifications on serum lipid levels:
   - fat-modified diet
   - combined fiber- and fat-modified diet
3. to investigate relationships among dietary and biochemical parameters

Part I: A Dietary Survey and Blood Lipid Screening Study

Part 1 A Dietary Survey and Blood Lipid Screening Study

METHODOLOGY

1. Selection of patients

The survey was conducted to evaluate the dietary intake of kidney patients undergoing dialysis and to identify blood lipid abnormalities. All dialysis patients registered at the University of Alberta Hospitals who met the following criteria were screened over a ten-month period:

(a) chronic kidney failure managed by dialysis for more than six months

(b) no requirement for insulin or steroids

(c) English speaking

(d) resident of the greater Edmonton area and available for a diet study

A total of 46 (26 men and 20 women) were entered into the study between June 1983 and April 1984. For the first six months recruitment was confined to continuous ambulatory peritoneal dialysis (CAPD) patients; 30 CAPD patients (15 men and 15 women) entered the study. For the last four months hemodialysis (HEMO) patients were recruited in

an attempt to enlarge the study group; 16 HEMO patients (11 men and 5 women) were accepted.

CAPD patients were selected from outpatients at the University of Alberta Hospitals. Each one was contacted by telephone, informed of the study and asked to have a fasting blood sample taken for lipid analysis. HEMO patients were selected from patients listed on the in-centre or home dialysis programs. The patients were approached either in the dialysis unit or by telephone and arrangements were made for a fasting lipid survey.

2 Dietary survey

The dietary survey took place between June 1983 and April 1984. The researcher, a registered dietitian, collected all the data. Each patient was interviewed by the dietitian who used the forty-eight hour recall method to estimate quantitatively the daily intakes of calories and nutrients (Smith and Gee 1979). The patient was asked to recall all foods and beverages consumed in the previous forty-eight hours. Graduated food models were used to assess the amounts of foods as in the Nutrition Canada National Survey, 1973. Detailed descriptions of each food item were obtained. The dietitian coded all items using a standard form and transferred the quantitative dietary data to computer tape for analysis of daily nutrient intake by the University of Alberta main-frame computer.

The nutrient data base was the Canadian Nutrient File (1983), (Verdier 1984), a data base derived from Handbook No. 456 of the United States Department of Agriculture into which has been incorporated Canadian food composition data for a total of over 3000 food items. Values for dietary fiber and cholesterol were added to the nutrient data base from Southgate's tables (Paul 1976) and from the Nutrition Coding Center, Minneapolis (Feeley 1972). Values for zinc were added to the tape from various sources: Revised Agricultural Handbook No. 8 (8-1 to 8-10, USDA 1976-1983), Murphy (1975), Freeland-Graves (1980), Freeland (1976), Lawler (1980), McNeill (1985). Computer programs converted volumes of foods to mass and then calculated nutrients per day.

Daily intakes of foods classified according to food groups were also obtained. In the nutrient data base, foods are categorized according to the United States Department of Agriculture food group code (Davenport 1964). Nutrient intakes were also assessed for the probability or risk that the observed intake is inadequate for the described individual (Anderson 1982). A software package designed by Dr. G.H.Beaton, University of Toronto, was used for this purpose on an Apple IIe micro-computer.

The dry weight of patients was obtained at the time of the dietary interview. Relative body weight was determined, using desirable weights as tabulated in the Metropolitan Life Insurance Company Statistical Bulletin

#40 (Nov/Dec, 1959). The circumference at the mid-point of the upper-arm was measured and mid-arm muscle circumference was calculated from the arm circumference. Triceps skinfold thickness was measured using the Lange skinfold caliper (Cambridge Scientific Industries, Cambridge Md).

For the CAPD patients it was necessary to consider the calories provided by the dialysate solution. The patient undergoing continuous ambulatory peritoneal dialysis received approximately two liters of dialysate four times daily with 1.50, 2.50 or 4.25 per cent D-glucose. The patients recorded the volume and concentration of dialysate used each day. Using the formula of Grodstein (1981), it was then possible to calculate the kilocalories obtained from glucose in the dialysate.

3. Blood lipid screening study

A fasting blood sample was taken for biochemical investigation. The following lipid assessments were obtained: triglycerides, total cholesterol and high density lipoprotein (HDL) cholesterol. Low density lipoprotein (LDL) cholesterol was calculated as total cholesterol minus (HDL-cholesterol + triglycerides/5) (Friedwald 1972). All determinations were performed by the Department of Laboratory Medicine at the Unversity of

Alberta Hospitals. In addition, the following routine biochemical measures were obtained: serum creatinine, serum albumin, hemoglobin, serum calcium, serum phosphorus, serum potassium and fasting blood glucose.

4. Data analysis

Descriptive statistics were calculated for different parameters. Student's t-test was used for data analysis.

RESULTS

Table 1.1 summarizes the characteristics of the study groups. Forty-six patients were studied (26 males, 20 females); the mean ages were 55.9 years for the males and 52.6 years for the females (range 24 to 78 years). There were thirty patients (15 males, 15 females), undergoing CAPD and sixteen (11 males, 5 females), undergoing HEMO.

Table 1.2 shows the nutritional measurements for the male and female groups and the CAPD and HEMO subgroups. The assessment profile evaluates deficits in somatic and visceral protein compartments. Relative body weights ranged from 76 to 150 per cent; mid-arm muscle circumference from 79 to 124 per cent of standard; and triceps skinfold thickness from 32 to 376 per cent of standard. Mid-arm muscle circumference measurements and triceps skinfold thickness measurements were less than 90% of standard for nine to sixty per cent of each group. The mean serum albumin value for the female CAPD group was the lowest, 3.7 g/dL compared to 3.9 and 4.0 for the other subgroups. The albumin level of the CAPD females was significantly lower ($p < 0.05$) than that of the CAPD males. Both the CAPD female group and the HEMO female group had one patient with a serum albumin level below the range for

TABLE 1.1
Basic characteristics of patients

Characteristic	Total group	CAPD	HEMO
Number of patients			
M*	26	15	11
F*	20	15	5
Age(yr)			
M	55.9 ± 13.7[1]	57.7 ± 14.1	53.3 ± 13.3
F	52.6 ± 16.4	52.0 ± 16.3	54.2 ± 18.4
Height (cm)			
M	178 ± 7	179 ± 7	176 ± 6
F	161 ± 7	161 ± 7	160 ± 7
Weight (kg)			
M	75.5 ± 12.3	76.3 ± 11.9	75.5 ± 13.3
F	59.1 ± 9.2	59.5 ± 8.6	57.5 ± 11.6

[1] mean ± standard deviation
* M = males, F = females

TABLE 1.2
Nutritional measurements of patients

Parameters	No. of subjects	Mean value	% of patients with the following degrees of normalcy		
			>90%	90-60%	<60%
Relative body weight %					
CAPD (M)	15	104 ± 17[a]	80	20	0
CAPD (F)	14	105 ± 15	71	29	0
HEMO (M)	11	106 ± 19	73	27	0
HEMO (F)	5	101 ± 16	80	20	0
MAMC % of standard					
CAPD (M)	15	96 ± 10	73	27	0
CAPD (F)	14	95 ± 12	71	29	0
HEMO (M)	11	95 ± 10	73	27	0
HEMO (F)	5	96 ± 13	60	40	0
TSF % of standard					
CAPD (M)	15	137 ± 91	60	20	20
CAPD (F)	14	100 ± 39	50	43	7
HEMO (M)	11	151 ± 94	91	0	9
HEMO (F)	5	100 ± 40	40	60	0
Serum albumin* (g/dL)					
CAPD (M)	14	4.0 ± 0.4**	100	0	0
CAPD (F)	14	3.7 ± 0.5	79	21	0
HEMO (M)	11	3.9 ± 0.5	91	9	0
HEMO (F)	5	3.9 ± 0.6	80	20	0

[a]Mean ± standard deviation
MAMC - mid-arm muscle circumference standard: age specific (Jette, M. Anthropometric Characteristics of the Canadian Population, 1983)
TSF - triceps skinfold thickness standard: (see MAMC above)
*normal value - 3.5 g/dL
**significance $p < .05$ - CAPD Male vs. CAPD Female

measurement (recorded as 2.9 g/dL).

The presence or absence of protein-energy malnutrition (PEM), was determined in the following way: PEM was diagnosed if each of three anthropometric measurements (body weight, mid-arm muscle circumference and triceps skinfold), was below 90% of the normal value or if the serum albumin concentration was below 3.5 g/dL. Nineteen per cent of the males and twenty-six per cent of the females were classified as being malnourished.

Table 1.3 shows the values for the biochemical parameters that are routinely measured. As is characteristic of end-stage renal failure, the mean serum creatinine levels were high (13.3 mg/dL for males, 11.5 mg/dL for females), and the mean hemoglobin concentrations were low (9.7 g/dL for males, 8.7 g/dL for females). Serum phosphorus levels were also high (5.4 mg/dL for males, 5.5 mg/dL for females), but well controlled with predialysis levels below 6.0 mg/dL. Serum calcium, serum potassium and fasting blood glucose levels fell within normal limits.

Serum lipid levels are shown in Table 1.4. The serum triglyceride levels were elevated with mean values of 257 mg/dL for males (range 50 to 673 mg/dL), and 211 mg/dL for females (range 85 to 386 mg/dL). These levels are at about the 90th percentile compared to data for the North American population (Nutrition Committee and Council on Atherosclerosis 1984). For the total group, serum

TABLE 1.3

Biochemical parameters

Parameter	Total group M n=26 F n=20	CAPD M n=15 F n=15	HEMO M n=11 F n=5
Serum creatinine (mg/dL)			
M	13.3 ± 3.3[1]	13.4 ± 3.8	13.3 ± 2.7
F	11.5 ± 2.8	11.9 ± 3.0	10.5 ± 2.0
Hemoglobin (g/dL)			
M	9.7 ± 1.8	9.6 ± 1.6	10.0 ± 1.8
F	8.7 ± 1.8	8.7 ± 2.1	8.8 ± 0.8
Serum potassium (mEq/L)			
M	4.5 ± 0.7	4.4 ± 0.6	4.7 ± 0.8
F	4.1 ± 0.5	3.9 ± 0.4	4.5 ± 0.4
Serum phosphorus (mg/dL)			
M	5.4 ± 1.5	5.3 ± 1.2	5.6 ± 1.9
F	5.5 ± 2.3	5.7 ± 2.6	4.8 ± 1.3
Serum calcium (mg/dL)			
M	9.5 ± 1.0	9.6 ± 0.6	9.3 ± 1.4
F	9.4 ± 1.3	9.3 ± 1.2	9.4 ± 1.9
Fasting blood glucose (mg/dL)			
M	102 ± 20	101 ± 12[a]	104 ± 27[c]
F	94 ± 16	91 ± 8[b]	102 ± 27[d]

a n=12
b n=13
c n=10
d n=5

[1] mean ± standard deviation

TABLE 1.4
Serum lipid levels

	Total group M n=25 F n=20	CAPD M n=14[a] F n=15	HEMO M n=11 F n=5
Triglyceride (mg/dL)			
M	257 ± 166[1]	279 ± 172	230 ± 162
F	211 ± 81	218 ± 92	192 ± 31
Total cholesterol (mg/dL)			
M	223 ± 60	245 ± 58*	196 ± 54
F	229 ± 60	240 ± 62	193 ± 38
VLDL-cholesterol (mg/dL)			
M	24 ± 17	28 ± 20	20 ± 12
F	18 ± 7	19 ± 8	17 ± 3
LDL-cholesterol (mg/dL)			
M	156 ± 54	180 ± 49**	122 ± 38
F	163 ± 52	176 ± 51***	125 ± 31
HDL-cholesterol (mg/dL)			
M	41 ± 9	40 ± 9	42 ± 10
F	47 ± 13	46 ± 14	52 ± 10
LDL-C/HDL-C			
M	4.0 ± 1.5	4.6 ± 1.3	3.1 ± 1.3
F	3.7 ± 1.6	4.0 ± 1.6	2.5 ± 0.7
Total-C/HDL-C			
M	5.6 ± 1.7	6.3 ± 1.7	4.6 ± 1.2
F	5.1 ± 1.7	5.5 ± 1.7	3.8 ± 0.7

* significant difference $p < 0.05$ CAPD males vs. HEMO males
** significant difference $p < 0.01$ CAPD males vs. HEMO males
*** significant difference $p < 0.05$ CAPD females vs. HEMO females
[a] one subject refused to have lipid evaluation done
[1] mean ± standard deviation

cholesterol averaged 225 mg/dL, VLDL-cholesterol averaged 20 mg/dL and LDL-cholesterol averaged 160 mg/dL. LDL-cholesterol levels for the CAPD males and females were significantly higher than the levels for HEMO males ($p<0.01$) and females ($p<0.05$). In addition, the mean total-cholesterol level for the CAPD males was significantly higher than the level for HEMO males ($p<0.05$). The mean HDL-cholesterol levels were low, which is typical of patients with end-stage renal failure; the values were 41 mg/dL for males, 47 mg/dL for females. The mean values for the ratio of LDL-cholesterol to HDL-cholesterol were 4.0 for the males and 3.7 for the females. For the ratio of total-cholesterol to HDL-cholesterol means were 5.6 for males and 5.1 for females.

The mean daily nutrient intakes for all patients in the survey are tabulated for males (Table 1.5) and for females (Table 1.6). Mean total energy intakes (food and dialysate) were 2110 kcal for males and 1541 kcal for females; energy intakes per kilogram of body weight averaged 27 to 32 kcal. Energy from protein averaged 13 to 15%; from fat, 31 to 40%; and from carbohydrate, 46 to 56% of calories. For the CAPD subgroups the proportion of energy derived from dialysate glucose was 12% of calories for males and 17% for females. Mean protein intakes were less than the levels recommended for dialysis patients. For the CAPD subgroups, mean protein intakes were 1.1 g/kg

TABLE 1.5
Mean daily nutrient intake: males

Dietary component	Total group n=26	CAPD n=15	HEMO n=11
Energy			
kcal/day	2110 ± 788[1]	2326 ± 848	1841 ± 639
kcal/kg	30 ± 11	32 ± 11	27 ± 9
Protein			
g/day	74 ± 29	80 ± 31	67 ± 26
g/kg	1.0 ± 0.4	1.1 ± 0.4	0.9 ± 0.4
% of kcal	15 ± 4	14 ± 3	15 ± 5
Fat			
Total(g)	87 ± 47	93 ± 50	79 ± 44
SFA*(g)	30.0 ± 14.9	32.1 ± 14.6	27.3 ± 15.5
MFA*(g)	33.4 ± 17.9	36.2 ± 19.9	30.7 ± 15.4
PUFA*(g)	15.4 ± 11.6	16.9 ± 13.5	14.4 ± 9.1
P/S** ratio	0.5 ± 0.2	0.5 ± 0.2	0.6 ± 0.3
Cholesterol(mg)	451 ± 264	516 ± 263	371 ± 253
% of kcal	36 ± 7	35 ± 6	37 ± 8
Carbohydrate			
Total(g)	265 ± 98	303 ± 101	218 ± 74
Sugar			
Food(g)	139 ± 65	175 ± 57	93 ± 42
Dialysate(g)	40 ± 43	71 ± 32	-
Starch(g)	112 ± 53	116 ± 60	107 ± 43
Crude fiber(g)	4.7 ± 2.7	5.4 ± 3.0	3.9 ± 1.9
Dietary fiber(g)	17 ± 8	18 ± 8	15 ± 7
% of kcal	50 ± 8	51 ± 6	48 ± 10
Ascorbic acid(mg)	112 ± 74	100 ± 61	126 ± 88
Thiamin(mg)	1.43 ± 0.49	1.53 ± 0.54	1.30 ± 0.41
Riboflavin(mg)	1.51 ± 0.52	1.66 ± 0.60	1.35 ± 0.38
Niacin(mg)	16.8 ± 5.5	18.0 ± 6.0	15.4 ± 4.7
Vitamin B_6(mg)	1.4 ± 0.5	1.5 ± 0.5	1.3 ± 0.4
Vitamin B_{12}(mcg)	3.9 ± 2.8	4.5 ± 3.0	3.2 ± 2.6
Folacin(mcg)	162 ± 70	168 ± 73	154 ± 68
Vitamin A(IU)	6529 ± 6434	6959 ± 7636	5991 ± 4801
Vitamin A(RE)	1205 ± 851	1382 ± 961	983 ± 665
Vitamin D(IU)	222 ± 167	284 ± 187	145 ± 96
Calcium(mg)	645 ± 291	714 ± 313	559 ± 246
Phosphorus(mg)	1176 ± 408	1275 ± 453	1054 ± 320
Iron(mg)	14.9 ± 5.2	14.7 ± 4.9	15.2 ± 5.8
Sodium(mg)	3018 ± 1484	3194 ± 1738	2798 ± 1126
Potassium(mg)	2448 ± 798	2703 ± 826	2129 ± 660
Zinc(mg)	10.1 ± 3.8	10.5 ± 4.4	9.5 ± 3.0

* SFA = saturated fatty acids, MFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids
** P/S = polyunsaturated to saturated fatty acid ratio

[1] mean ± standard deviation

TABLE 1.6
Mean daily nutrient intake: females

Dietary component	Total group n=19	CAPD n=14[1]	HEMO n=5
Energy			
kcal/day	1541 ± 360[2]	1539 ± 367	1548 ± 384
kcal/kg	27 ± 7	27 ± 6	28 ± 8
Protein			
g/day	53 ± 19	53 ± 20	55 ± 16
g/kg	0.9 ± 0.4	1.0 ± 0.3	0.9 ± 0.4
% of kcal	14 ± 5	13 ± 4	14 ± 4
Fat			
Total(g)	58 ± 20	54 ± 20	70 ± 20
SFA*(g)	21.0 ± [illegible]	20.4 ± 8.3	22.7 ± 10.1
MFA*(g)	21.0 ± [illegible]	19.3 ± 7.0	25.6 ± 6.2
PUFA*(g)	9.8 ± [illegible]	8.0 ± 4.1	14.9 ± 7.5
P/S** ratio	0.5 ± [illegible]	0.4 ± 0.2	0.7 ± 0.4
Cholesterol(mg)	332 ± 163	350 ± 171	286 ± 144
% of kcal	33 ± 7	31 ± 7	40 ± 5
Carbohydrate			
Total(g)	209 ± 56	220 ± 55	180 ± 52
Sugar			
Food(g)	112 ± 44	128 ± 39	68 ± 25
Dialysate(g)	49 ± 43	67 ± 35	-
Starch(g)	87 ± 31	83 ± 31	98 ± 31
Crude fiber(g)	3.3 ± 1.4	3.2 ± 1.5	3.7 ± 0.9
Dietary fiber(g)	13 ± 6	13 ± 7	13 ± 2
% of kcal	53 ± 9	56 ± 9	46 ± 2
Ascorbic acid(mg)	84 ± 67	86 ± 74	78 ± 47
Thiamin(mg)	0.98 ± 0.36	0.93 ± 0.38	1.12 ± 0.30
Riboflavin(mg)	1.06 ± 0.38	1.03 ± 0.39	1.13 ± 0.39
Niacin(mg)	12.9 ± 4.7	13.0 ± 4.9	12.8 ± 4.5
Vitamin B_6(mg)	1.1 ± 0.5	1.1 ± 0.5	0.9 ± 0.4
Vitamin B_{12}(mcg)	2.5 ± 2.1	2.7 ± 2.4	2.0 ± 0.6
Folacin(mcg)	124 ± 50	114 ± 47	155 ± 49
Vitamin A(IU)	4458 ± 2912	5074 ± 3113	2733 ± 1273
Vitamin A(RE)	761 ± 339	818 ± 352	601 ± 267
Vitamin D(IU)	90 ± 65	71 ± 56	145 ± 61
Calcium(mg)	448 ± 243	422 ± 225	523 ± 302
Phosphorus(mg)	823 ± 316	818 ± 338	841 ± 279
Iron(mg)	10.6 ± 3.6	10.5 ± 4.0	11.0 ± 2.3
Sodium(mg)	1857 ± 598	1782 ± 568	2045 ± 726
Potassium(mg)	1727 ± 625	1705 ± 667	1789 ± 554
Zinc(mg)	6.8 ± 2.6	6.6 ± 2.8	7.3 ± 2.3

[1] one patient refused to provide dietary intake information

[2] mean ± standard deviation

* SFA = saturated fatty acids, MFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids
** P/S = polyunsaturated to saturated fatty acid ratio

of body weight for males and 1.0 g/kg for females, less than the target of 1.5 g protein per kilogram of body weight (Kopple, 1984). For the HEMO subgroups, mean protein intakes were 0.9 g/kg of body weight for both males and females, less than the target of 1.2 g/kg of body weight (Kopple, 1984). For most of the other nutrients, mean intakes were not markedly different from those reported for the population at large. However, folacin intakes were below the recommended level: the mean daily intake for males was 162 mcg (recommended - 220 mcg); for females, 124 mcg (recommended - 190 mcg). The mean calcium intakes of 645 mg for males and 448 mg for females were below the recommended level (800 mg). For the females, the mean daily zinc intake was 6.8 mg, less than the recommended intake of 8 mg; for the males it was greater than the recommended intake. However, as many authors have suggested that zinc depletion may lead to anorexia in patients undergoing dialysis, the food sources of zinc were examined more closely. Table 1.7 indicates the amount of zinc contributed by each food group. The majority was derived from meat and cereal products (Table 1.7).

The range of nutrient intakes for individuals in the survey group was wide. For example, average energy intakes ranged from 900 to 4590 kilocalories for males and from 1114 to 2304 kilocalories for females. Table 1.8 shows the percentage distribution of the energy intake

TABLE 1.7
Zinc content of the diet by food groups

Food group	Males			Females		
	Total group n=26	CAPD n=15	HEMO n=11	Total group n=19	CAPD n=14	HEMO n=5
	g	g	g	g	g	g
MPFE*	4.5	4.9	4.1	3.3	3.3	3.2
Dairy products	1.1	1.2	0.9	0.6	0.5	0.7
Cereal products	2.3	2.0	2.6	1.6	1.5	2.0
Vegetables	1.2	1.5	1.0	0.8	0.7	0.8
Nuts	0.1	0.1	0.1	0	0	0
Friut products	0.3	0.2	0.3	0.2	0.2	0.2
Fats and oils	0	0	0	0	0	0
Foods primarily sugar	0	0	0	0	0	0
Other	0.5	0.5	0.6	0.3	0.3	0.3
Total	10.0	10.4	9.6	6.8	6.6	7.3

*MPFE = meat, poultry, fish and eggs

TABLE 1.8
Percentage distribution of energy intake values

Energy intake kcal/kg body weight/day	CAPD		HEMO	
	Males	Females	Males	Females
	n=15	n=14	n=11	n=5
	%	%	%	%
0 - 10	0	0	0	0
10 - 20	0	14	28	20
20 - 25	26	36	18	20
25 - 30	26	7	18	20
30 - 40	28	43	36	40
> 40	20	0	0	0

values. There were a considerable number of low energy intakes of less than 25 kcal/kg body weight/day. 26% and 50% of CAPD males and females and 46% and 40% of HEMO males and females had energy intakes of less than 25 kcal/kg body weight.

Table 1.9 shows the percentage distribution of protein. A large portion of the patients had protein intake values of less than 1 g/kg body weight/day. 53% and 57% of CAPD males and females and 46% and 40% of HEMO males and females had protein intakes of less than 1 g/kg body weight. In fact, less than 20% of the CAPD patients met the target of 1.5 g protein/kg and less than 40% of the HEMO patients met the target of 1.2 g protein/kg.

Table 1.10 shows a probability estimate of true deficiencies for several nutrients (calculated by the computer program "Probability Assessment of Nutrient Intake", format by DR. G.H.Beaton). The nutrients most commonly deficient in the diets were as follows (in decreasing order): calcium, folacin, vitamin A, zinc, vitamin D, niacin, vitamin C, protein, riboflavin, thiamin. The percentage risks were greater for the females than for the males. For calcium and folacin, both sexes were at particularly high risk: for calcium, the percentage risk was 73 for females and 49 for males. For protein and vitamin B_6 the percentage risks are likely underestimated because the measure of adequacy is the Canadian dietary standard; the needs of dialysis patients

TABLE 1.9
Percentage distribution of protein intake values

Protein intake g/kg body weight/day	CAPD Males n=15	CAPD Females n=14	HEMO Males n=11	HEMO Females n=5
	%	%	%	%
0 - 0.5	0	14	19	0
0.5 - 0.7	13	14	0	20
0.7 - 1.0	40	29	27	20
1.0 - 1.2	20	22	27	20
1.2 - 1.5	14	14	27	40
> 1.5	13	7	0	0

TABLE 1.10
Mean per cent risk that observed intake is below requirement*

	Total group n=45	Males n=26	Females n=19
	%	%	%
Protein	19	12	25
Thiamin	13	5	20
Riboflavin	16	8	24
Niacin	30	14	45
Folacin	48	44	51
Vitamin B_{12}	23	15	30
Vitamin B_6	3	3	3
Vitamin C	22	21	23
Vitamin A	37	38	35
Vitamin D	30	14	45
Calcium	61	49	73
Iron	7	1	13
Zinc	31	18	44

* microcomputer software package "Probability Assessment of Nutrient Intake" by G.H.Beaton

are greater.

For some of the nutrients, the use of supplements increased intake as shown in Table 1.11. The average intake of iron, thiamin, riboflavin, niacin, vitamin C, vitamin B_6, folacin were dramatically affected by supplement use. Total intake of folacin from food plus supplement reached levels of 2109% of recommended for males and 2528% of recommended for females.

The data presented in Table 1.12 indicate the nutrient densities (nutrients per 1000 kilocalories) of the diets of males and females compared with optimal densities based on the Recommended Nutrient Intake. Nutrient density provides a measure of the nutrient quality of a diet. Densities of calcium intakes were below the RNI densities. Densities of all nutrients for males and females were very similar.

Food intakes were also assessed in terms of food groups. The average quantities of grams of foods in each group ingested are shown in Table 1.13 for males and Table 1.14 for females. The average total weight of food consumed by males and females was low in comparison to the amounts consumed by the average Canadian. Study females consumed 930 grams per day from all food groups compared to 1156 grams per day for Nutrition Canada females. Both males and females consumed less dairy products than the average Canadian, perhaps because restriction of milk is usually recommended with end-stage renal failure to

TABLE 1.11
Contribution of supplements to nutrient intake

	Males		Females	
	without supplement	with supplement	without supplement	with supplement
	% of RNI*		% of RNI	
Thiamin	151	1669	129	1989
Riboflavin	129	906	108	1038
Niacin	99	407	90	446
Vitamin B_6	93	407	83	967
Folacin	77	2109	73	2528
Ascorbic acid	188	662	45	858
Calcium	81	100	62	81
Iron	189	540	114	869

* RNI = Recommended Nutrient Intakes for Canadians, 1983

TABLE 1.12
Mean daily dietary intake expressed as nutrient density per 1000 kiloclories

Nutrient	Males n=26	Recommended intake/1000 kcal	Females n=19	Recommended intake/1000 kcal
Protein (g)	35	43*	34	40*
Thiamin (mg)	0.68	0.40	0.64	0.40
Riboflavin (mg)	0.72	0.50	0.69	0.40
Niacin (mg)	8.0	7.2	8.4	7.2
Folacin (mcg)	77	94	80	96
Vitamin B_{12} (mcg)	1.8	0.9	1.6	1.0
Vitamin B_6 (mg)	0.7	1.0**	0.7	1.0**
Ascorbic acid (mg)	53	26	55	23
Vitamin A (RE)	571	427	494	413
Vitamin D (IU)	105	43	58	52
Calcium (mg)	306	341	291	395
Iron (mg)	7.1	3.4	6.9	4.9
Zinc (mg)	4.8	3.8	4.4	4.1
Dietary fiber (g)	8	-	8	-

* current recommendation for dialysis patients (Kopple, 1984)
** based on 2.0 mg/[illegible] minimum B_6 requirement (Kleiner, 1980)

TABLE 1.13
Mean daily intake of food groups: males

Food groups[1]	Mean intake n=26		Nutrition Canada[2]	
	grams	% of total intake	grams	%
MPFE[3]	198 ± 141[4]	15	211	14
Dairy products	200 ± 188	15	322	22
Cereal products	233 ± 109	17	269	18
(refined)	(158) ± 102	(11)		
(unrefined)	(76) ± 96	(6)		
Fruit products	266 ± 234	20	194	13
Vegetables	265 ± 177	20	265	17
Fats and oils	33 ± 30	2	29	1.5
Nuts	3 ± 7	-	15	0.5
Foods primarily sugar	24 ± 23	2	56	4
Other	130 ± 156	9	150	10
Total	1352 ± 488	100	1521	100

[1] categories described in Food Consumption Patterns Report; a report from Nutrition Canada, 1976

[2] males 40 to 64 years of age

[3] MPFE = meat, poultry, fish and eggs

[4] mean ± standard deviation

TABLE 1.14
Mean daily intake of food groups: females

Food groups[1]	Mean intake n=19		Nutrition Canada[2]	
	grams	% of total intake	grams	%
MPFE[3]	135 ± 67[4]	15	145	12
Dairy products	109 ±111	12	225	19
Cereal products	182±106	20	174	15
(refined)	(141)±118	(15)		
(unrefined)	(41)±51	(5)		
Fruit products	184±147	20	239	21
Vegetables	199±102	21	215	19
Fats and oils	22±15	2	20	2
Nuts	1±2	-	10	1
Foods primarily sugar	20±18	2	39	3
Other	78±92	8	89	8
Total	930±313	100	1156	100

[1] catagories described in Food Consumption Patterns Report; a report from Nutrition Canada, 1976

[2] females 40 to 64 years of age

[3] MPFE = meat, poultry, fish and eggs

[4] mean ± standard deviation

control phosphate levels. Consumption of fruit products and vegetables was greater for the males than the females. The intake of cereal products was similar to that of the average Canadian. We examined the cereal intake more closely and found that whole grain products accounted for only a small portion. One unexpected finding was that "foods primarily sugar" accounted for less of the patients intake than was the case for the average Canadian, even though patients undergoing maintenance dialysis are encouraged to consume sugar to increase total kilocalories.

DISCUSSION

The most striking finding of the survey was the low protein intake of outpatients receiving maintenance dialysis. The protein intake of the survey group averaged 1.0 gram per kg body weight per day compared to the recommended levels of 1.2 and 1.5 grams (Kopple, 1984). Protein intakes were less than 1.0 g/Kg/day for half of the patients. In fact some had intakes of less than 0.5 g/kg (14% of the CAPD females and 19% of the HEMO males).

Protein intake is especially important for dialysis patients because protein is lost during dialysis, especially continuous ambulatory peritoneal dialysis. It is estimated that 6 to 13 grams of protein are lost during each day of maintenance peritoneal dialysis (Kopple, 1983) and this quantity is increased during an episode of peritonitis (it can transiently exceed 100 g/day). With hemodialysis only minute amounts of protein are lost but free amino acids are removed in amounts of 6 to 10 grams during each run. During dialysis therapy, nutrient losses and the metabolic response to these losses may promote wasting and malnutrition.

Depleted anthropometric measurements and low values for serum concentrations of many proteins indicate a need for more protein and energy. Relative body weights of

less than 90% of desirable were found in 24 % of the patients. Triceps skinfold thickness was less than 90% of the standard in 27% of the patients and mid-arm muscle circumference measurement was less than 90% of the standard in 29 % of the patients. Serum albumin levels were abnormally low (under 3.5 g/dL) in 10% of the males and 20% of the females. Comparison of the mean serum albumin values for the subgroups revealed that the value for the CAPD females was significantly lower than the values for the CAPD males ($p < 0.05$). Out of the entire study group, we classified nineteen per cent of the males and twenty-six per cent of the females as having protein-energy malnutrition (PEM). PEM was diagnosed if each of three anthropometric measurements (body weight, mid-arm muscle circumference, and triceps skinfold thickness) were below 90% of the standard or if the serum albumin concentration was below 3.5 g/dL (Bansal,1980). It appears that patients undergoing regular dialysis therapy often eat too little protein rather then too much. Close monitoring of dietary intake is warranted with special methods to increase protein intake to the desired level during episodes of catabolic illness.

Another factor contributing to the poor nutritional status of the survey group was a marginal energy intake. The average intake for the survey group was very similar to the values reported for a recent survey of the United States population (Nationwide Food Consumption Survey USDA

1977/78). Of the two subgroups, the HEMO patients had the lowest intakes: for the HEMO males the average energy intake was 1841 kilocalories, as opposed to 2326 for the CAPD males. For dialysis patients an energy intake of 35 to 40 kilocalories per kg is recommended (Kopple, 1984); in this survey mean energy intake was 30 kilocalories per kg for males and 27 kilocalories for females. Furthermore, there were many low individual values: intakes of less than 25 kilocalories per kg were reported for 56% of the CAPD females and 40% of the HEMO females; intakes of less than 25 kilocalories per kg were reported for 26% of the CAPD males and 56% of the HEMO males. Several studies have reported that the mean dietary energy intake of maintenance dialysis patients is below normal and contributes to wasting and malnutrition (Kopple 1978[a], Kluthe 1978, Blumenkrantz 1980). However, the energy requirement for chronically uremic patients has never been defined. Some studies indicate that patients are already wasted when they commence dialysis therapy. One recent report examines the energy requirement for the nondialyzed patient with chronic renal failure. The diets fed provided energy in amounts of 45, 35, 25 and 15 kilocalories per kg per day and 0.55 to 0.60 grams protein per kg per day. Nitrogen balance correlated directly with energy intake (Kopple 1986). It was observed that a dietary intake of about 35 kilocalories per kg per day appeared to be required to maintain neutral or positive

nitrogen balance, maintain or increase body mass and reduce net urea generation.

Intakes of many other nutrients besides protein and energy appeared to be inadequate. For the following nutrients the mean daily intake was below the recommended level; folacin and calcium and vitamin B_6 for the males and zinc, vitamin B_6, calcium, vitmin A and folacin for the females. The mean risk of deficiency was highest for calcium (61%) and folacin (48%) but was sizable for many nutrients including vitamin A (37%), zinc (31%), vitamin C (22%), niacin (30%), vitamin D (30%) and riboflavin (16%). Risks were greater for females than males. Inadequacies of intakes of a few nutrients were decreased by the use of supplements (folacin, ascorbic acid, thiamin, riboflavin, niacin, vitamin B_6). Predicted deficiencies estimated from data collected for the healthy population are if anything an underestimate for the kidney patient whose nutrient needs may be greater.

In the case of vitamin B_6, there is an increased metabolic clearance of the vitamin and an increased requirement. However, this deficiency has not been explained nor has there been a systematic study to determine the requirement of vitamin B_6. A dose of 10 mg per day is currently recommended for the dialysis patient (Kopple 1984), compared to the normal recommended allowance of less than 2 mg. In this survey, the mean daily vitamin B_6 intake was 1.4 mg for the males and 1.1

mg for the females (18 and 19 mcg/g protein respectively). Deficiency of vitamin B_6 is characterized by decreased levels of pyridoxal phosphate and reduced activity of the enzyme erythrocyte glutamic oxaloacetic transaminase. Dobblestein (1974) found that with a dose of 50 mg vitamin B_6, suppressed cell-mediated immunity improved. Vitamin B_6 deficiency may contribute significantly to the pathogenesis of abnormal amino acid and lipid metabolism in dialysis patients. Kleiner (1980) found that high-density lipoprotein levels increased significantly after two weeks of oral supplementation with 300 mg of vitamin B_6 daily.

There is little information on the zinc intakes of kidney patients, but research has indicated that zinc depletion in hemodialysis patients may lead to alteration in taste and smell as well as loss of appetite. In our study, the predicted deficiencies of zinc are estimated to be 18% of the males and 44% of the females. The finding of nutrient inadequacies in the survey group is noteworthy because the stress of illness can worsen the situation. In addition, drug intake can often interfere with nutrient utilization.

The CAPD patients in particular, are vulnerable to nutrient deficiencies. With CAPD, glucose absorption averages 160 to 180 grams per day according to Kopple i.e. up to 750 kilocalories per day. This means that if nutrient needs are to be met, all the nutrients needed

must be supplied in relatively few kilocalories. Hence the nutrient density of the foods selected must be great. We found that dialysate glucose absorption provided an average of 71 grams per day sugar for the CAPD males and 67 grams per day sugar for the CAPD females. However, the range of daily sugar from dialysate varied from 17 g to 141 g for the males and from 16 g to 125 g for the females. Glucose absorption is especially high when a more concentrated dialysate solution is used to take off excess water.

The assessment of intake in terms of food groups revealed more problems. The survey group consumed less dairy products and less meat, poultry, fish and eggs (MPFE) than the average Canadian (Nutrition Canada survey data, 1976). It is interesting to note that the intake of "foods primarily sugar" was less than that reported in the Nutrition Canada survey data even though dialysis patients are encouraged to increase their intake of sugars and fat to increase energy intake. Consumption of fats and oils was greater than that of the average Canadian, but the percentage of calories derived from fat was only 36% for the males and 33% for the females. The most striking finding was the low food intake of the survey group compared to the average Canadian. In fact, a reduction in food intake along with a restriction of the number of foods used can reduce the intake of certain nutrients disproportionately. These patients are very familiar with

dietary restrictions of protein, fluid, sodium and potassium intake. Previous instruction has limited the allowable foods in their minds and made it more difficult to increase their energy and nutrient intake. If their diet is not closely monitored, the patients tend to eat too little, not too much.

Serum triglyceride levels were elevated for the dialysis patients surveyed as indicated by the high mean values of 257 mg/dL for the males (95th percentile for the North American population) and 211 mg/dL for the females (over the 90th percentile. High serum triglycerides have been reported to be characteristic of patients undergoing dialysis (Bagdade 1968). It was also found that the patients undergoing continuous ambulatory dialysis had higher serum total cholesterol and LDL-cholesterol levels than the patients undergoing hemodialysis. For the CAPD patients these levels were over the 75th percentile. The LDL-cholesterol level for the CAPD males (180 mg/dL) was significantly higher ($p < 0.01$) than the level (122 mg/dL) for the HEMO males. The level for the CAPD females (176 mg/dL) was significantly higher ($p < 0.05$) than the level for the HEMO females (125 mg/dL). For the males total cholesterol was also significantly higher for the CAPD subgroup (245 mg/dL) than for the HEMO subgroup (196 mg/dL). It is possible that for the CAPD patients, the continuous exposure to dialysate glucose may elevate serum cholesterol levels. Differences in the effect of sucrose

and starch on serum cholesterol has been examined. McGandy (1966) found that serum cholesterol levels were slightly higher during a sugar-rich diet than a starch-rich diet in a controlled experiment. However, Mann and Truswell (1972) reported that there was no difference between the effect of sugar and starch on cholesterol levels. The quality of fat in the diets may explain some of the controversy because saturated fat may potentiate the lipid-raising effect of sugar (Antar 1970, Liu 1984). For a few patients, malnutrition may be exerting a lipid-lowering effect. The HDL-cholesterol levels of the females were remarkably low (below the 25th percentile); for the males HDL-cholesterol levels were below the 50th percentile.

CONCLUSIONS

1. Many of the patients surveyed consumed less than the desirable amount of protein and Calories. Protein intake was less than one gram per kg body weight for 55% of the CAPD patients and 44% of the HEMO patients. Energy intake was less than 25 kcal/kg for 50% and 26% of the CAPD patients (females and males respectively) and for 40% and 56% of the HEMO patients (females and males respectively).

2. Protein-energy malnutrition is widespread among stable dialysis patients; 19% of males and 26% of females were classified as having protein-energy malnutrition. Subnormal nutritional measurements were documented for many patients. Triceps skinfold thickness measurements were subnormal for 50% of CAPD and 60% of HEMO females and 40% of CAPD and 9% of HEMO males. Mid-arm muscle circumference measurements were subnormal for 29% of CAPD and 40% of HEMO females and 27% of both CAPD and HEMO males. Serum albumin levels were subnormal for 21% and 20% of CAPD and HEMO females respectively and 9% of HEMO males (0% of CAPD males). Among females, low levels of serum albumin were associated with low protein intakes.

3. The intake of many nutrients would appear to be inadequate according to the basic nutritional requirements known. The most common findings were deficient intakes of calcium, folacin, zinc, vitamin A, ascorbic acid and thiamin. The prevalence of dietary deficiencies suggests the need to place more emphasis on adequate nutrition and less emphasis on foods to avoid in the nutritional care of dialysis patients.

4. There is a need to increase the nutrient density of intakes, especially in the case of the CAPD patient obtaining as much as 30% of Calories from glucose in the dialysate. As the proportion of kilocalories from dialysate glucose increases it becomes more difficult to balance the diet in terms of nutrients. In this survey, dialysate glucose contributed an average of approximately 10% of total kilocalories.

5. Amongst stable dialysis patients, a reduction in food intake associated with a simplified pattern of food choices can reduce the intake of certain nutrients disproportionately. Many kidney patients consider diet modifications to limit access to desired foods rather than to support well-being. Greater emphasis needs to be placed on improving the quality of food intake.

6. Elevated serum triglyceride levels were prevalent amongst the stable dialysis patients. The mean triglyceride for the males was 257 mg/dL (95th percentile for the North American population); for the females it was 211 mg/dL (over 90th percentile). Comparison of the CAPD and HEMO subgroups revealed that the mean serum LDL-cholesterol levels were significantly higher for the CAPD group ($p < 0.01$ for males; $p < 0.05$ for females). In addition, the mean serum total cholesterol level for the CAPD males was significantly higher than that for the HEMO males ($p < 0.05$).

Part II: A Study to Examine the Effects of Dietary Treatment on Serum Lipids of Patients Undergoing Dialysis

METHODOLOGY

1. Selection of patients

Serum lipid concentrations (triglyceride, cholesterol and HDL-cholesterol) of eligible patients had been determined for the survey. This enabled us to select patients with eleveted serum triglyceride levels of over 160 mg/dL. Of the thirty CAPD patients screened between June 1983 and January 1984, twenty-three were selected who met all of the following criteria:

(a) chronic kidney failure managed by dialysis for more than six months

(b) elevated serum triglyceride level (over 160 mg/dL)

(c) no requirement for insulin or steroids

(d) English speaking

(e) resident of the greater Edmonton area and accessible for follow-up

The study was explained to these patients and six agreed to participate and signed the consent form (Appendix 1). Reasons for not participating in the study included the following:

(a) not accessible for regular follow-up

(b) medically unstable

(c) unwilling to conform to the strict protocol (including no consumption of alcohol)

(d) deceased

Of the six CAPD patients enrolled in the study, five completed the study, one died.

Although the study was originally to be restricted to CAPD patients, in January 1984 it became necessary to include hemodialysis patients to obtain a large enough study group. Of the sixteen HEMO patients screened between January 1984 and April 1984, ten were selected who met the criteria. Of these, seven entered the study and six completed the study (one patient drank heavily at Christmas and was excluded). The HEMO group was comprised of both patients dialyzing at home and patients dialyzing "in-center". The total study group consisted of twelve patients (six males and six females). There were six CAPD patients (three males and three females) and six HEMO patients (three males and three females).

2. Experimental design

The study was designed to examine the effect of the following dietary modifications on serum lipid levels:

(a) fat-modified diet (P/S ratio > 1.5)

(b) combined fiber- and fat-modified diet

The experimental design contained three parts, each of three months in length. The first was the baseline period; baseline data (dietary, biochemical and clinical) were collected, no dietary treatment was given. In the

second part (diet period I), patients were placed on a fat-modified diet consisting of approximately 40% of kilocalories from fat, 45% from carbohydrate (including dialysate glucose) and 15% from protein, with a polyunsaturated/saturated (P/S) ratio of at least 1.5. In the third part (diet period II), a fiber modification was introduced along with the fat modification from the [redacted]s period. The dietary fiber intake was to be at [redacted]15 grams per 1000 kilocalories in the form of cereals, legumes, fruits and vegetables. One dietitian provided individualized diet counselling and collected quantitative dietary data throughout the study.

Serum lipid and lipoprotein cholesterol levels were measured twice each period (one week apart). Differences in serum lipid levels between the baseline period and the experimental diet periods were assessed. Additional parameters were evaluated including:

vitamin and mineral supplements
glucose absorbed from dialysate (CAPD patients)
body height, dry weight
triceps skinfold thickness
mid-arm muscle circumference
serum creatinine
serum albumin
hemoglobin
serum calcium, phosphorus, potassium
fasting blood glucose

The usual standard medical management was provided for the patients throughout the study.

3. Dietary methodology

3.1 Dietary intake data collection

Four-day diet records were used for the assessment of dietary intakes. Several of the patients lived a considerable distance from Edmonton, and the use of four-day diet records made possible the regular collection of dietary data. Eleven sets of records were collected from each patient, three from the baseline and four from each diet period. The days were selected to ensure a sample of week days and week-end days in their true proportion of all days. The schedule for assigning the dates for record-keeping appears in Table 2.1. Table 2.1 also shows the scheduling of lipid and biochemical assessments. When necessary, minor adjustments were made in the schedule to [illegible] of activities.

The patients were carefully instructed how to record food intake using common household measures; the form used appears in Appendix 2. The four-day records were returned to the dietitian in person or by mail. The records were reviewed by the researcher, a dietitian and if necessary patients were contacted to clarify details. The dietitian had been in practice for several years and was experienced

TABLE 2.1
Research design

	Dietary evaluation	Lipid assessment	Biochemical assessment
Control period			
week #0		lipid	biochem.
week #1	4-day diet record		
week #6	signing of consent form		
week #6		lipid	biochem.
week #7	4-day diet record	lipid	
week #11	4-day diet record		
week #12			biochem.
Treatment period I			
week #12	diet counselling		
week #13	4-day diet record		
week #17	4-day diet record		
week #18	diet counselling	lipid	biochem.
week #19	4-day diet record	lipid	
week #23	4-day diet record		
week #24			biochem.
Treatment period II			
week #24	diet counselling		
week #25	4-day diet record		
week #29	4-day diet record		
week #30	diet counselling	lipid	biochem.
week #31	4-day diet record	lipid	
week #35	4-day diet record		
week #36		lipid	biochem.

in interpreting dietary information. When the patient returned to the University of Alberta Hospitals for routine follow-up, the dietitian had an opportunity to obtain more information about eating patterns; standardized food models assisted in the estimation of portion sizes. The 48-hour recall collected for the dietary survey was used as a cross check. The quantitative assessment of food intakes was completed by the dietitian; standardized techniques were used for recording the data and coding the food items. The data were transferred to computer tape for analysis of daily nutrient intake by the University of Alberta main-frame computer. Daily intakes were calculated for energy, protein, total fat, saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, cholesterol, total carbohydrate, sugar, starch, crude fiber, dietary fiber, ascorbic acid, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, folacin, vitamin A, vitamin D, calcium, phosphorus, iron, sodium, potassium and zinc.

Intakes of foods classified according to food groups were also obtained and nutrient intakes were assessed for the probability that the observed intake was inadequate for the individual. Daily intakes were expressed as nutrient density and also assessed for the probability that the observed intake was inadequate for the individual.

3.2 Diet counselling

Individualized diet counselling was provided by the dietitian. The fat-modified diet used in diet period I was planned to contain 40% of Calories from fat (P/S ratio > 1.5). The objectives of the fat-modified diet are outlined in Table 2.2. The combined fiber- and fat-modified diet used in diet period II, was planned to contain 15 grams of dietary fiber per 1000 kilocalories as outlined in Table 2.2. Hand-outs were provided for the patients to explain some of the terminology (Appendix 3). Both diets were designed to be nutritionally adequate, meeting Canadian Dietary Standard recommendations. The daily caloric allowance was individualized to attain and/or maintain desirable weight. For the CAPD patients it was necessary to consider the calories provided by the dialysate solution. The patient undergoing continuous ambulatory peritoneal dialysis received approximately two liters of dialysate four times daily with 1.50, 2.50 or 4.25 per cent D-glucose. The patients recorded the volume and concentration of dialysate used each day. Using the formula of Grodstein (1981), it was then possible to calculate the kilocalories obtained from glucose in the dialysate.

The diet plan set up for each patient made use of an exchange system similar to the diabetic food exchange

TABLE 2.2
Objectives of dietary treatment

Diet period I - Fat-modified diet
Kilocalories to attain and maintain desirable weight
Carbohydrate - 45% of kcal
Protein - 15% of kcal
Fat - 40% of kcal
Cholesterol - less than 300 mg/day
P/S ratio - 1.5 or greater
Potassium (HEMO patients only) - less than 2700mg/day
Sodium - 2 to 4 grams per day
Fluid - on an individual basis
Diet period II - Combined fiber- and fat-modified
Kilocalories to attain and maintain desirable weight
Carbohydrate - 45% of kcal
Protein - 15% of kcal
Fat - 40% of kcal
Cholesterol - less than 300 mg/day
P/S ratio - 1.5 or greater
Dietary fiber - 15 g/1000 kcal
Potassium (HEMO patients only) - less than 2700mg/day
Sodium - 2 to 4 grams/day
Fluid on an individual basis

system. Each patient was allotted a daily quota of exchanges with the freedom to choose foods from various food lists. Two sets of exchange lists were prepared; one for the CAPD patients (Appendix 4), the other for HEMO patients (Appendix 5), as the HEMO patients require the additional control of potassium intake. For the fat-modified diet, several patients found it difficult to use the prescribed quantity of oil, so a list of suggestions was prepared (Appendix 6). Recipes were also provided for the patients (Appendix 7).

For the combined fiber- and fat-modified diet the exchange lists were altered as follows:

(a) fruit and vegetable juices were replaced by products containing more fiber i.e. fresh, frozen or canned products

(b) refined bread and cereal products were replaced by whole grain products including oat bran (Appendix 8)

A list of suggestions for increasing the fiber content of the diet was prepared (Appendix 9) and a set of high-fiber recipes was given to patients (Appendix 10). Patients were provided with guidelines to assist in the selection of commercial products (Appendix 11).

Each patient received intensive instruction concerning his special diet. Initially each patient completed a questionaire to provide the dietitian with information regarding the family situation, cooking

facilities and other factors influencing dietary intake. When diet counselling began each patient was asked to bring the person preparing the meals at home. A written reminder was sent to each patient prior to the appointment (Appendix 12). The individualized meal plan which met the established dietary goals was then discussed with the patient and accompanying family member. The accurate estimation of the portion sizes of foods, in particular the portion sizes of meat, fish, and poultry was considered to be essential if dietary objectives were to be met, thus patients were instructed to weigh meat portions using Hanson dietetic scales. The use of standard measuring cups and spoons was encouraged for estimating portion sizes of other foods.

Each patient was followed closely by the dietitian. Contacting the patient by phone during the first two weeks on a modified diet enabled the dietitian to solve some of the practical problems. Diet counselling sessions were scheduled when the patient came to the clinic for blood tests (Table 2.1). At this time diet patterns were reviewed and diet plans were revised if necessary.

4. Anthropometric measurements

Anthropometric measurements were collected by the dietitian at regular intervals (every six weeks). The following measurements were recorded: height, dry weight,

triceps skinfold thickness, mid-arm muscle circumference.

5. Biochemical Methods

Blood samples for routine biochemical tests were taken on entry and at weeks 6, 12, 18, 24, 30, and 36 (Table 2.1). All determinations were performed by the Department of Laboratory Medicine at the University of Alberta Hospitals using standard methods. The following biochemical measurements were obtained: serum creatinine serum albumin, hemoglobin, serum calcium, serum phosphorus, serum potassium and fasting blood glucose.

A serum lipid survey was done on entry and on two occasions during each of the three study periods, at weeks 6, 7, 18, 19, 30, 31 and 36 (Table 2.1). Triglycerides, cholesterol and HDL-cholesterol were determined after a 12-hour dietary fast. Serum triglyceride was determined on the Abbott bichromatic analyzer (Abbott Diagnostics, South Pasadena CA) using the lipase-esterase glycerokinase reaction as described by Schmidt and von Dahl (1968). Serum cholesterol was determined by the method of Abell and co-workers (1958) using the Lieberman-Burchard reaction. HDL-cholesterol was determined after manganese-heparin precipitation (Burstein 1970)according to the method of Klose (1975). LDL-cholesterol was calculated as total cholesterol minus (HDL-cholesterol + triglyceride/5) (Friedwald 1972).

Because two lipid assessments were obtained in each period, with an interval of one week between assessments, it was often necessary for blood samples to be drawn in the vicinity of the patient's home. Arrangements were made with out-of-town laboratories or local emergency departments to draw blood samples and send them to the Department of Laboratory Medicine at the Univeristy of Alberta Hospitals for analysis (Appendix 13 shows the list of instructions given to off-site laboratories).

6. Standard Patient Management

Each patient remained under the supervision of his physician throughout the study. Vitamin supplements are routinely given to patients undergoing dialysis and each patient maintained his vitamin supplement protocol during the study. The most usual prescription was the following:

> thiamin 15 mg, riboflavin 10 mg, niacin 50 mg, vitamin B_6 5 mg, folacin 5000 mcg, pantothenate 10 mg and ascorbic acid 300 mg daily.

Each patient consumed an oral phosphate binder with meals and snacks to reduce phosphorus absorption. The following preparations were used: Basaljel, Amphojel, calcium carbonate. In addition, some patients received iron and calcium supplements.

7. Data analysis

Since multiple determinations of a given measurement were made for each subject during each period of the study, a single mean value for each subject was used to calculate mean values for the group and to perform the statistical analyses. The significance of differences in serum lipid levels was assessed by analysis of paired differences where every patient is compared to his own control (Snedcor 1975). For the dietary data the sigificance of differences was assessed by analysis of variance. Student's t-test was used to evaluate clinical data. Pearson correlation coefficients were calculated to examine interrelationships across the three study periods between: serum lipid levels, selected dietary parameters, selected clinical parameters. Interrelationships between the intake of different nutrients was also examined by means of Pearson correlation coefficients. The criteria of significance was $p < 0.01$ because of the small sample size. The computerized Statistical Package for the Social Sciences ($SPSS^X$), 1983, was used.

RESULTS

Description of the study group

Table 2.3 [illegible] the characteristics of the study group. The study group comprised 6 men and 6 women ranging in age from 43 to 63 years, mean 54. Six of the patients were undergoing continuous ambulatory peritoneal dialysis (CAPD) and six were undergoing hemodialysis (HEMO). Relative body weights ranged from 86 to 121 per cent, mean 103 per cent. Baseline anthropometric measurements revealed that mid-arm muscle circumferences ranged from 82 to 107 per cent of standard, mean 93 per cent of standard; triceps skinfold thicknesses ranged from 46 to 376 per cent of standard, mean 121 per cent of standard.

The study group consisted of patients whose medical condition was fairly stable. This is supported by the baseline routine biochemical findings described in Table 2.4. The mean serum creatinine level was 13.3 mg/dL, typical of end-stage renal failure. Serum creatinine levels ranged from 10.4 to 16.3 mg/dL compared to the normal range of 0.6 to 1.2 mg/dL. The mean values for serum potassium and serum calcium were within the normal range; they were 4.6 mEq/L and 9.8 mg/dL respectively.

TABLE 2.3
Basic characteristics of study group

Characteristic	Total group	Males	Females
Number of patients	12	6	6
Age (yr)	54 ± 7[1]	54 ± 7	53 ± 7
Type of dialysis:			
Number of patients undergoing			
CAPD	6	3	3
HEMO	6	3	3
"in-center"	3	2	1
at home	3	1	2
Height (cm)	169 ± 12	178 ± 10	160 ± 7
Weight (kg)	66.6 ± 12.4	73.5 ± 12.1	59.6 ± 8.6
Desirable body weight[2] (kg)		72.8 ± 7.4	56.7 ± 4.5
Relative body weight[3] %	103 ± 11	101 ± 11	105 ± 11
TSF[4] (mm)	19.5 ± 12.5	14.5 ± 13.1	24.6 ± 11.5
% of standard[4]	121 ± 89	135 ± 123	106 ± 43
MAMC[5] (cm)	23.3 ± 3.5	25.9 ± 1.9	20.6 ± 2.5
% of standard[5]	93 ± 9	95 ± 7	91 ± 11

[1] values are means ± standard deviation

[2] Metropolitan Life Insurance Co. Statistical Bulletin 40 Nov-Dec 1959

[3] Blackburn et al, 1977

[4] TSF = triceps skinfold thickness
standard: age-specific (Jette M., Anthropometric Characteristics of the Canadian Population. 1983)

[5] MAMC = mid-arm muscle circumference
standard: age-specific (Jette M., Anthropometric Characteristics of the Canadian Population. 1983)

TABLE 2.4
Biochemical parameters: baseline

Parameter	Total group n=12	Males n=6	Females n=6
Serum creatinine (mg/dL)	13.3 ± 2.0[1]	14.1 ± 2.3	12.4 ± 1.5
Serum albumin (g/dL)	4.0 ± 0.2	4.0 ± 0.2	4.0 ± 0.2
Hemoglobin (g/dL)	9.4 ± 1.9	10.0 ± 2.2	8.8 ± 1.4
Serum potassium (mEq/L)	4.6 ± 0.5	5.0 ± 0.5	4.3 ± 0.3
Serum phosphorus (mg/dL)	5.5 ± 1.1	5.3 ± 1.2	5.7 ± 0.9
Serum calcium (mg/dL)	9.8 ± 0.6	9.7 ± 0.3	9.8 ± 0.8

[1] mean ± standard deviation

As is typical of patients with end-stage renal failure, hemoglobin levels were low and serum phosphorus levels tended to be high. The mean hemoglobin levels for males and females was 10.0 and 8.8 g/dL respectively. The mean serum phosphorus level was 5.5 mg/dL, higher then the upper limit of normal, 5.0 mg/dL. All patients consumed oral phosphate binders each day to control serum phosphorus levels!

2. Baseline data

2.1 Dietary intake

Dietary intakes in the baseline period were assessed and the results are shown in Table 2.5. The mean daily energy intake (including kilocalories from the absorbed dialysate glucose), was 1571 kilocalories; for the males it was 1652 and for the females, 1491 kilocalories. The total energy intake of the males and females was remarkably similar. Per cent of calories from fat, carbohydrate and protein were 33, 51 and 16 respectively. The mean cholesterol intake was 322 mg/day and dietary fiber intake was 12 g/day. The polyunsaturated/saturated (P/S) fatty acid ratio for the baseline period was 0.4.

Table 2.6 shows the impact of dialysate glucose on the percentage distribution of calories. For the six patients undergoing CAPD, glucose in the dialysate

TABLE 2.5
Mean daily intake of selected dietary components: baseline

	Total group n=12	Males n=6	Females n=6
Kilocalories[1]	1571 ± 445[2]	1652 ± 556	1491 ± 334
CHO (% of kcal)	51 ± 9	48 ± 6	54 ± 10
dietary carbohydrate	41 ± 7	3 ± 6	40 ± 9
dialysate glucose	10 ± 13	5 ± 8	14 ± 16
Protein (% of kcal)	16 ± 4	17 ± 5	15 ± 2
Fat (% of kcal)	33 ± 8	35 ± 8	31 ± 8
Cholesterol (mg)	322 ± 156	352 ± 203	292 ± 100
P/S ratio	0.4 ± 0.2	0.3 ± 0.3	0.5 ± 0.1
Dietary fiber			
(g/1000 kcal)	8 ± 3	7 ± 3	8 ± 2
(g/day)	12 ± 5	11 ± 5	13 ± 5
Potassium (mg/day)			
total	1889 ± 502	1945 ± 406	1832 ± 618
CAPD subgroup	2145 ± 602	2282 ± 217	2008 ± 895
HEMO subgroup	1632 ± 187	1608 ± 158	1657 ± 246

[1] total kilocalories from food and dialysate glucose

[2] mean ± standard deviation

TABLE 2.6
Comparison of percentage distribution of kilocalories with and without dialysate glucose

	Percentage distribution of kilocalories		
	Carbohydrate	Protein	Fat
	% of kcal	% of kcal	% of kcal
Males (n=3)			
Diet only	45	16	39
Diet + dialysate	50	15	35
Females (n=3)			
Diet only	48	18	34
Diet + dialysate	62	13	25

contributed from 63 to 464 kilocalories per day. The three patients who required the more concentrated dialysate solution containing 4.25% glucose, obtained the most calories in this way. When the glucose in the dialysate is taken into consideration, the per cent of calories from carbohydrate increases and the per cent of calories from fat and protein decreases. The per cent of calories from fat in the baseline period was 35% and 25% for the males and females respectively, rather than the 39% and 34% recorded for food only, without dialysate glucose.

2.2 Serum lipid levels

Table 2.7 indicates the serum lipid levels for the baseline period. The mean serum triglyceride level for the total group was 278 mg/dL. For the males and females the mean serum triglyceride values were 336 and 221 mg/dL respectively; both values are at the 95th percentile for the North American population.

For the total group the ratios of LDL-cholesterol to HDL-cholesterol and serum cholesterol to HDL-cholesterol were 4.4 and 5.8 respectively. The mean values for total cholesterol, VLDL-cholesterol and LDL-cholesterol were at the 75th percentile in comparison to the levels of the North American population. The mean value for HDL-cholesterol was at the 25th percentile in comparison

TABLE 2.7
Serum lipid levels: baseline

	Total group n=12	Males n=6	Females n=6
Triglyceride (mg/dL)			
	278 ± 118[1] (137-506[2])	336 ± 122 (205-506)	221 ± 87 (137-357)
Total cholesterol (mg/dL)			
	243 ± 72 (152-397)	238 ± 88 (152-397)	248 ± 62 (170-314)
VLDL-cholesterol (mg/dL)			
	24 ± 10 (12-41)	29 ± 10 (17-41)	19 ± 7 (12-31)
LDL-cholesterol (mg/dL)			
	173 ± 71 (46-321)	169 ± 90 (46-321)	177 ± 55 (114-251)
HDL-cholesterol (mg/dL)			
	46 ± 16 (26-82)	39 ± 11 (26-56)	53 ± 19 (43-82)
LDL-C/HDL-C	4.4 ± 2.5	4.6 ± 2.4	3.9 ± 2.6
Total-C/HDL-C	5.8 ± 2.6	6.4 ± 2.4	5.3 ± 2.8

[1] mean ± standard deviation

[2] range

to the levels of the North American population.

3. Modidified diet period I (fat-modified diet)

3.1 Dietary intake

Table 2.8 shows the daily intake of selected dietary components for diet period I (fat-modified diet). The mean daily total energy intake was 1584 kilocalories; for the males it was 1674 kilocalories and for the females, 1510 kilocalories. The distribution of calories was as follows: fat - 36%; carbohydrate - 48% and protein - 16% of calories. The P/S ratio of 1.5 was significantly greater than the P/S ratio of 0.4 for the baseline period; the target of a P/S ratio of 1.5 was achieved. The cholesterol intake of 215 mg per day for diet period I also met the target. The dietary fiber intake for diet period I averaged 10 g/1000 kilocalories. Carbohydrate was obtained from both dietary sources (38% of kilocalories) and from dialysate glucose (10% of kilocalories. The dialysate glucose contributed more calories for the females (13% of kilocalories) than for the males (7% of kilocalories).

3.2 Serum lipid levels

Table 2.9 shows the effect on serum lipid levels when

TABLE 2.8
Mean daily intake of selected dietary components: fat-modified diet

	Total group n=11	Males n=5[1]	Females n=6
Kilocalories	1584 ± 348[2]	1674 ± 323	1510 ± 379
CHO (% of kcal)	48 ± 8	47 ± 6	50 ± 9
dietary carbohydrate	38 ± 8	40 ± 6	37 ± 10
dialysate glucose	10 ± 13	7 ± 8	13 ± 16
Protein (% of kcal)	16 ± 3	17 ± 3	15 ± 3
Fat (% of kcal)	36 ± 7	36 ± 6	35 ± 8
Cholesterol (mg/day)	215 ± 79	259 ± 96	179 ± 39
P/S ratio	1.5 ± 0.5	1.3 ± 0.3	1.7 ± 0.5
Dietary fiber			
(g/1000 kcal)	10 ± 4	10 ± 5	10 ± 3
(g/day)	16 ± 6	16 ± 6	16 ± 6
Potassium (mg/day)			
total	2142 ± 632	2312 ± 758	2001 ± 537
CAPD subgroup	2278 ± 755	2671 ± 808	1885 ± 554
HEMO subgroup	1980 ± 477	1773 ± 150	2117 ± 610

[1] one patient refused to complete 4-day food records

[2] mean ± standard deviation

TABLE 2.9
Effects of fat-modified diet on serum lipid levels

	Baseline n=12	Period I n=12	Per cent difference
Triglyceride (mg/dL)	278 ± 118[1]	207 ± 92	-26
Total cholesterol (mg/dL)	243 ± 72	208 ± 58	-14
VLDL-cholesterol (mg/dL)	24 ± 10	18 ± 8	-25
LDL-cholesterol (mg/dL)	173 ± 71	145 ± 51	-16
HDL-cholesterol (mg/dL)	46 ± 16	45 ± 17	-2
LDL-C/HDL-C	3.8 ± 2.4	3.8 ± 2.0	0
Total-C/HDL-C	5.1 ± 2.3	5.4 ± 2.4	-6

[1]mean ± standard deviation

the patients changed from their usual intake (baseline period) to the fat-modified diet. The effect of modifying the fat content of the diet was as follows: mean triglyceride level and mean VLDL-cholesterol level were significantly lower; the reductions were 26% and 25% respectively. Total cholesterol and LDL-cholesterol were also significantly lower, decreasing by 14% and 16% respectively. The decrease in HDL-cholesterol was small (2%). On the fat-modified diet the ratio of LDL-cholesterol to HDL-cholesterol did not change and that of total serum cholesterol to HDL-cholesterol fell by 6%.

4. Modified diet period II (combined fiber- and fat-modified diet)

4.1 Dietary intake

Table 2.10 shows the daily intake of dietary components for diet period II (combined fiber- and fat-modified diet). The mean daily energy intake was 1680 kilocalories; for the males it was 1744 kilocalories and for the females, 1661 kilocalories. The distribution of calories was as follows: fat - 37%; carbohydrate - 46% and protein - 17% of kilocalories. The P/S ratio for diet period II was 1.7 and the cholesterol intake was 215 mg per day. The dietary fiber intake for diet period II averaged 15 g/1000 kilocalories, significantly higher than

TABLE 2.10
Mean daily intake of selected dietary components: combined fiber- and fat-modified diet

	Total group n=10	Males n=5	Females n=5[1]
Kilocalories	1680 ± 433[2]	1744 ± 390	1661 ± 547
CHO (% of kcal)	46 ± 6	48 ± 6	46 ± 7
dietary carbohydrate	39 ± 7	42 ± 7	38 ± 7
dialysate glucose	7 ± 10	6 ± 9	8 ± 11
Protein (% of kcal)	17 ± 3	17 ± 2	15 ± 3
Fat (% of kcal)	37 ± 6	35 ± 6	39 ± 5
Cholesterol (mg/day)	215 ± 70	256 ± 68	173 ± 47
P/S ratio	1.7 ± 0.6	1.4 ± 0.4	2.1±0.6
Dietary fiber			
(g/1000 kcal)	15 ± 3	15 ± 4	14 ± 2
(g/day)	24 ± 7	25 ± 8	24 ± 7
Potassium (mg/day)			
total	2651 ± 921	2877 ± 1133	2425 ± 706
CAPD subgroup	2992 ± 1117	3370 ± 1264	2425 ± 849
HEMO subgroup	2309 ± 609	2137 ± 332	2425 ± 798

[1] one patient died

[2] mean ± standard deviation

8 g/1000 kilocalories for the baseline period and meeting the target of 15 g/1000 kilocalories.

Table 2.11 shows the sources of dietary fiber in the diets of males and females for the baseline period, modified-diet period I and modified-diet period II. The combined fiber- and fat-modified diet (modified-diet II) was designed to contain as much fiber as feasible; a mean intake of 24 grams per day was achieved. The intake was significantly greater than that of the baseline period and modified-diet period I. Cereal products contributed the greatest amount of fiber to the diet although vegetables, friut and nuts also contributed to the total fiber intake.

4.2 Serum lipid levels

Table 2.12 shows the difference in serum lipid levels between the baseline period and the second diet period. The decrease in the mean levels of triglycerides and VLDL-cholesterol was 31 and 29% respectively ($p < .05$). Total cholesterol and LDL-cholesterol were reduced significantly by 18 and 20% respectively. The decrease in HDL-cholesterol was small (4%). On the combined fiber- and fat-modified diet the ratio of LDL-cholesterol to HDL-cholesterol fell by 5% and that of total serum cholesterol to HDL-cholesterol fell by 9%.

TABLE 2.11
Dietary fiber content of the diet by food groups

Food Group	Dietary Fiber (g/day)					
	Baseline		Period I		Period II	
	M*	F*	M	F	M	F
	n=6	n=6	n=5	n=6	n=5	n=5
Cereal products	4.7	5.1	7.2	4.6	14.5	13.4
Vegetables	3.9	4.8	5.7	6.6	6.0	4.6
Nuts	0.4	0	0.5	0.8	0.7	1.7
Fruit products	1.7	2.7	3.3	4.0	3.7	4.3
Other	0.1	0.3	0	0	0	0
Total (g/day)	11	13	17	16	25	24

*M = males, F = females

TABLE 2.12
Effects of combined fiber- and fat-modified diet on serum lipid levels

	Baseline n=12	Diet period II n=11	Per cent difference
Triglyceride (mg/dL)			
	278 ± 118[1]	193 ± 54	-31
Total cholesterol (mg/dL)			
	243 ± 72	200 ± 62	-18
VLDL cholesterol (mg/dL)			
	24 ± 10	17 ± 5	-29
LDL cholesterol (mg/dL)			
	173 ± 71	139 ± 60	-20
HDL cholesterol (mg/dL)			
	46 ± 16	44 ± 18	-4
LDL-C/HDL-C	3.8 ± 2.4	3.6 ± 2.1	-5
Total-C/HDL-C	5.4 ± 2.4	4.9 ± 2.2	-9

[1] mean ± standard deviation

5. Overall results

5.1 Dietary intake

Mean daily intakes of dietary components for the three study periods are summarized in Table 2.13. The proportion of fat and carbohydrate did ~~not~~ change much throughout the entire study: fat was 33 to 37 per cent of kilocalories, carbohydrate, 46 to 51 per cent of kilocalories and protein, 16 to 17 per cent of kilocalories. The quality of fat in the diet was altered in diet period I. The P/S ratio was increased significantly from 0.4±0.2 in the baseline period to 1.5 ± 0.5 ($p < 0.001$) and dietary cholesterol intake was reduced significantly from 322 ± 156 mg daily to 215 ± 79 mg ($p < 0.05$). The quality of carbohydrate in the diet was altered in diet period II. The mean dietary fiber intake increased significantly from 16 ± 6 g in period I to 24 ± 7 in period II ($p < 0.01$) and from 12 ± 5 g in the baseline ($p < 0.001$). The fat modification of period I was maintained. In period II the P/S ratio of 1.7 ± 0.6 was not significantly different from the P/S ratio in period I; the mean cholesterol intake was 215 mg, the same as it was in period I. Thus, the intake of period II can truly be categorized as a combined fiber- and fat-modified diet.

TABLE 2.13
Summation of mean daily intakes of selected dietary components in the three study periods.

	Baseline n=12	Period I n=11	Period II n=10
Fat			
% of kcal	33 ± 8	36 ± 7	37 ± 6
P/S ratio	0.4 ± 0.2[1a]	1.5 ± 0.5[b]	1.7 ± 0.6[bc]
cholesterol(mg)	322 ± 156[a]	215 ± 79[b]	215 ± 70[bc]
Carbohydrate			
% of kcal	51 ± 9	48 ± 8	46 ± 6
sugar	26 ± 12	23 ± 12	19 ± 10
dietary fiber	12 ± 5[a]	16 ± 6[a]	24 ± 7[b]
Protein			
% of kcal	16 ± 4	16 ± 3	17 ± 3

[1] means ± standard deviation

Values for a given parameter without a common letter in their superscript are significantly different ($p < 0.05$). Statistical test used was analysis of variance.

5.2 Lipid lowering effects of diets

Lipid levels for each study period are summarized in Table 2.14. Compared with those during the baseline, serum triglyceride levels were significantly lower during the two modified diets ($p < 0.05$); the reduction during the consumption of the combined fiber- and fat-modified diet was greater (31%) than the reduction during the consumption of the conventional fat-modified diet (26%). The mean serum triglyceride fell from 278 mg/dL in the baseline period to 207 mg/dL in diet period I and to 193 mg/dL in diet period II. Serum VLDL-cholesterol concentrations were significantly lower in period II than during the baseline period ($p < 0.05$). Similar trends were noted in the changes in total serum cholesterol and LDL-cholesterol; the reductions during the consumption of the fat-modified diet were 14% and 16% respectively and the reductions during the consumption of the combined fiber- and fat-modified diet were 18% and 20% respectively. The mean serum cholesterol fell from 243 mg/dL in the baseline period to 208 mg/dL in diet period I and to 200 mg/dL in diet period II. Serum cholesterol levels were significantly lower during the two modified diets ($p < 0.01$). Serum LDL-cholesterol levels were also significantly lower during the two modified diets. All

TABLE 2.14
Summation of serum lipid responses of the study group

	Baseline n=12	Period I n=12	Period II n=11
Triglyceride (mg/dL)	278 ± 118[1a]	207 ± 92[b]	193 ± 54[b]
Total cholesterol (mg/dL)	243 ± 72[a]	208 ± 58[b]	200 ± 62[b]
VLDL-cholesterol (mg/dL)	24 ± 10[a]	18 ± 8[ab]	17 ± 5[b]
LDL-cholesterol (mg/dL)	173 ± 71[a]	145 ± 51[b]	139 ± 60[b]
HDL-cholesterol (mg/dL)	46 ± 16[a]	45 ± 17[a]	44 ± 18[a]

[1]means ± standard deviation

Values for a given parameter without a common letter in their superscript are significantly different ($p < 0.05$). Statistical test used was analysis of paired differences (Snedecor 1975).

reductions were greatest during the consumption of the combined fiber- and fat-modified diet. HDL-cholesterol was lowered by both diets; the decrease was small and not significant. On both diets the ratio of total serum-cholesterol to HDL-cholesterol fell and in period II the ratio of LDL-cholesterol to HDL-cholesterol fell by 5%.

5.3 Lipid levels as related to dietary intake

Interrelationships between mean dietary intakes and mean serum lipid levels for individual subjects across the three study periods were assessed. Pearson correlation coefficients are presented in Table 2.15 comparing serum lipid data and the following dietary intake parameters: P/S ratio, dietary cholesterol, dietary fiber, total dietary sugar, starch and energy. A significant negative correlation was noted between dietary fiber intake and serum triglycerides ($p < 0.01$) and VLDL-cholesterol ($p < 0.01$) and between dietary starch and serum total cholesterol ($p < 0.01$). A significant positive correlation was also noted between dietary kilocalories and HDL-cholesterol levels. There was a positive correlation between total sugar and serum total cholesterol and LDL-cholesterol levels ($p < 0.001$), probably due to the

TABLE 2.15
Pearson correlation coefficients: mean serum lipid levels vs. selected mean dietary components in three study periods[1]

Variable	Serum triglyceride	Serum cholesterol			
		total	VLDL	LDL	HDL
P/S ratio	-0.406	-0.284	-0.404	-0.307	+0.239
Dietary cholesterol (mg)	+0.152	+0.378	+0.118	+0.390	-0.028
Dietary fiber (g)	-0.476*[2]	-0.143	-0.446*	-0.139	+0.210
Sugar (g)	+0.337	+0.781**	+0.341	+0.688**	+0.353
Starch (g)	-0.342	-0.482*	-0.329	-0.427	-0.147
Dietary energy (kcal)	-0.112	+0.243	-0.107	+0.332	+0.463*

[1] based on data for 12 subjects, 3 study periods

[2] Correlation coefficient significant

* $p < 0.01$

** $p < 0.001$

marked response of the CAPD patients.

Although we did not find significant correlations between the components of the fat-modified diet and blood lipid levels, the major lipid-lowering effect occurred during the fat-modified diet period I. The marked differences in individual responses to the diet probably accounted for this lack of correlation. Table 2.16 shows the observed changes in blood lipid levels in individual patients during period I (fat-modified diet). The fat-modified diet had its greatest effect when the initial serum lipid levels were high. Patient #2 (PP) for example, showed hypertriglyceridemia and hypercholesterolemia at the beginning of the study and experienced marked decreases in all lipid fractions during period I; triglyceride (-33%), total cholesterol (-32%), VLDL-cholesterol (-32%), and LDL-cholesterol (-37%). During period I there were significant reductions in triglycerides ($p < 0.05$), total cholesterol ($p < 0.01$), and LDL-cholesterol ($p < 0.05$) for the total group. For the males there was also a significant reduction in VLDL-cholesterol ($p < 0.05$).

5.4 Clinical data

Table 2.17 shows the clinical data for the baseline period and diet periods I and II. In general patients

TABLE 2.16
Observed changes in blood lipid levels (mg/dL) in patients on a fat-modified diet

	PE	PP	SO	SL	PC	JL	EG	LB	MH	YSP	AB	KU	Avg
Patient	1	2	3	4	5	6	7	8	9	10	11	12	
Serum Triglyceride													
control	289	424	208	205	506	385	292	137	357	213	173	151	278
period #1	155	283	161	198	166	214	345	138	403	172	162	85	207
change	-134	-141	-47	-7	-340	-171	+53	+1	+46	-41	-11	-66	-72
% change	46	33	23	3	67	44	+18	+1	+13	19	6	44	-26
Serum Cholesterol													
control	194	397	263	182	152	241	300	293	314	194	219	170	243
period #1	177	268	260	172	102	181	279	219	290	207	189	145	208
change	-17	-129	-3	-10	-50	-60	-21	-74	-24	+13	-30	-25	36
% change	9	32	1	6	33	25	7	25	8	+7	14	15	-14
VLDL - Cholesterol													
control	26	37	17	18	41	34	22	12	31	19	15	13	24
period #1	14	25	14	20	14	19	30	12	35	15	11	8	18
change	-12	-12	-3	+2	-27	-15	+8	0	+4	-4	-4	-5	-6
% change	46	32	18	+11	66	44	+36	0	+13	21	27	38	-25
LDL - Cholesterol													
control	143	320	201	136	46	165	251	198	218	124	154	114	173
period #1	132	201	195	126	49	123	223	120	202	135	138	93	145
change	11	119	6	10	+3	42	28	78	16	+11	16	21	28
% change	8	37	3	7	+7	25	11	39	7	+9	10	18	-16

TABLE 2.17
Summation of clinical data for three study periods

	Baseline n=12	Period I n=12	Period II n=11
Relative body weight (%)			
	103 ± 11[1]	103 ± 12	100 ± 13
Energy intake as % of basal requirement			
	113	115	111
MAMC (cm)			
	23.3 ± 3.5	23.3 ± 4.4	21.4 ± 3.0
% of standard	93 ± 9	93 ± 11[a]	87 ± 9[b]
TSF (mm)			
	19.5 ± 12.5	18.4 ± 11.0	16.6 ± 7.9
% of standard	121 ± 89	104 ± 38[a]	90 ± 14[b]
Episodes of illness			
Males	0	2 peritonitis 4 hospitalizations 2 surgery	2 peritonitis
Females	1 peritonitis	2 peritonitis	1 surgery
Serum albumin (mg/dL)			
	4.0 ± 0.2	3.9 ± 0.4	3.9 ± 0.4
Hemoglobin (g/dL)			
	9.4 ± 1.9	9.1 ± 2.0	9.0 ± 1.5
Serum potassium (mEq/L)			
	4.6 ± 0.5	4.5 ± 0.4	4.6 ± 0.3
Serum phosphorus (mg/dL)			
	5.5 ± 1.1	5.2 ± 1.1	5.4 ± 1.4
Serum calcium (mg/dL)			
	9.8 ± 0.6	9.5 ± 0.8	9.2 ± 0.9
Serum creatinine (mg/dL)			
	13.3 ± 2.0	12.6 ± 2.2	11.6 ± 1.9*
Fasting blood glucose (mg/dL)			
	6.0 ± 1.4[d]	6.6 ± 1.8[c]	5.9 ± 1.7[a]

[1] means ± standard deviation

[a] n=10

[b] n=5

[c] n=8

[d] n=11

* serum creatinine period II significantly different from baseline ($p < 0.05$)

maintained body weight through most of the study. However, the mean body weight decreased in diet period II to 100% from 103% of desirable body weight. One CAPD patient in particular lost 4.8 kilograms; during the course of the study he had three bouts of peritonitis. The patients were ill frequently during the study; the history of illness included seven episodes of peritonitis, four hospitalizations and two patients with heart disease, one of whom died before the study was completed. During period I the males in particular experienced many episodes of illness. Five of the six males were ill during period I; four were hospitalized (one for a coronary bypass), the fifth had two bouts of peritonitis. There were no significant changes in the following parameters: serum albumin and hemoglobin, serum potassium, serum phosphorus or serum calcium. No untoward effects were reported during consumption of the two modified diets; in fact serum creatinine levels decreased significantly from 13.3 mg/dL in the baseline period to 11.6 mg/dL during diet period II ($p < 0.05$).

Presented in Table 2.18 are Pearson correlation coefficients comparing serum lipid data with the following clinical parameters: body weight, serum creatinine, serum albumin and serum phosphorus in the three study periods. A significant positive correlation was noted between serum creatinine levels and serum LDL-cholesterol level ($p < 0.01$). A significant negative correlation was noted

TABLE 2.18
Pearson correlation coefficients: mean serum lipid levels vs. selected mean clinical parameters in three study periods[1]

Variable	Serum triglyceride	Serum cholesterol			
		total	VLDL	LDL	HDL
Body weight (kg)	+0.192	-0.011	+0.206	+0.078	-0.444*[2]
Serum creatinine (mg/dL)	+0.211	+0.397	+0.231	+0.479*	-0.317
Serum albumin (g/dL)	+0.000	-0.460*	+0.023	-0.341	-0.542**
Serum phosphorus (mg/dL)	+0.143	+0.495*	+0.176	+0.543**	-0.122

[1] Based on data for 12 subjects, 3 study periods

[2] Correlation coefficient significant

*p <0.01

**p <0.001

between serum albumin and serum total cholesterol level ($p < 0.01$). Serum phosphorus levels were positively correlated with two serum lipid parameters: serum total cholesterol and LDL-cholesterol. There were significant negative correlations between HDL-cholesterol and serum albumin levels ($p < 0.001$) and body weight ($p < 0.01$).

6. Diet Quality

6.1 Nutrient intake

The mean daily nutrient intakes for the three study periods are tabulated for men (Table 2.19) and for woman (Table 2.20). For the males, energy intake was low compared to figures reported for the general population in Canada and the United States. In fact, the energy intake for males and females was similar. For the following nutrients mean intakes were below recommended levels: folacin, calcium and zinc. For the males, the intakes of folacin, calcium and zinc during the baseline period were less than the recommended amounts (RNI); folacin was 60% of recommended, calcium, 80% and zinc 93%. The intakes of these nutrients improved throughout the study. The intakes of protein and vitamin B_6 were also below the levels considered to be adequate for the kidney patient but improved during the study.

TABLE 2.19
Mean daily nutrient intakes for three study periods: males

Dietary component	Baseline n=6	Period I n=5[1]	Period II n=5[1]
Energy			
kcal/day	1652 ± 556[2]	1674 ± 323	1744 ± 390
kcal/kg	22 ± 6	23 ± 4	24 ± 4
Protein			
g/day	70 ± 17	72 ± 13	78 ± 12
g/kg	0.9 ± 0.2	1.0 ± 0.1	1.1 ± 0.1
Fat			
Total(g)	66 ± 34	69 ± 21	72 ± 28
SFA*(g)	25.5 ± 16.0	16.2 ± 5.6	16.8 ± 5.0
MFA*(g)	24.6 ± 12.8	24.4 ± 7.7	25.2 ± 8.0
PUFA*(g)	8.4 ± 4.9	21.1 ± 5.8	23.2 ± 12.0
P/S**ratio	0.3 ± 0.3	1.3 ± 0.3	1.4 ± 0.4
Cholesterol(mg)	352 ± 203	259 ± 96	256 ± 68
Carbohydrate			
Total(g)	198 ± 64	198 ± 44	207 ± 45
Sugar			
Food(g)	75 ± 27	61 ± 28	55 ± 28
Dialysate(g)	23 ± 36	17 ± 38	24 ± 38
Starch(g)	89 ± 16	100 ± 11	104 ± 25
Crude fiber(g)	3.3 ± 1.8	4.3 ± 1.2	6.2 ± 1.6
Dietary fiber(g)	11 ± 5	16 ± 6	25 ± 8
Ascorbic acid(mg)	65 ± 31	98 ± 45	91 ± 29
Thiamin(mg)	1.28 ± 0.34	2.16 ± 1.03	1.71 ± 0.68
Riboflavin(mg)	1.48 ± 0.42	1.38 ± 0.37	1.42 ± 0.39
Niacin(mg)	16.7 ± 3.6	17.5 ± 3.8	19.1 ± 3.7
Vitamin B_6(mg)	1.3 ± 0.3	1.5 ± 0.3	1.8 ± 0.7
Vitamin B_{12}(mcg)	4.4 ± 4.6	4.6 ± 5.3	6.7 ± 6.9
Folacin(mcg)	131 ± 26	165 ± 32	196 ± 49
Vitamin A(IU)	5914 ± 2979	5975 ± 3011	7353 ± 3371
Vitamin A(RE)	1176 ± 790	1231 ± 1019	1428 ± 957
Vitamin D(IU)	177 ± 37	271 ± 91	295 ± 125
Calcium(mg)	640 ± 285	604 ± 219	645 ± 215
Phosphorus(mg)	1049 ± 310	1087 ± 269	1338 ± 291
Iron(mg)	12.8 ± 3.9	14.0 ± 2.4	16.0 ± 3.4
Sodium(mg)	2614 ± 892	2890 ± 1551	2315 ± 757
Potassium(mg)	1945 ± 406	2313 ± 758	2877 ± 1133
Zinc(mg)	8.4 ± 3.8	8.5 ± 1.6	10.6 ± 2.0

[1] one patient refused to complete 4-day diet records

[2] mean ± standard deviation

* SFA = saturated fatty acids, MFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids

** P/S = polyunsaturated to saturated fatty acid ratio

TABLE 2.20
Mean daily nutrient intakes for three study periods: females

Dietary component	Baseline n=6	Period I n=6	Period II n=5[1]
Energy			
kcal/day	1491 ± 334[2]	1510 ± 379	1661 ± 547
kcal/gm	27 ± 8	27 ± 8	29 ± 11
Protein			
g/day	57 ± 13	60 ± 15	65 ± 19
g/kg	1.0 ± 0.3	1.1 ± 0.3	1.1 ± 0.3
Fat			
Total(g)	52 ± 17	61 ± 23	74 ± 28
SFA*(g)	19.2 ± 7.1	13.8 ± 3.7	15.6 ± 4.9
MFA*(g)	19.2 ± 6.4	17.1 ± 5.0	19.6 ± 6.1
PUFA*(g)	8.6 ± 2.7	25.1 ± 13.3	33.0 ± 14.8
P/S ratio	0.5 ± 0.1	1.7 ± 0.5	2.1 ± 0.6
Cholesterol(mg)	292 ± 100	179 ± 39	173 ± 47
Carbohydrate			
Total(g)	208 ± 70	192 ± 55	197 ± 74
Sugar			
Food(g)	58 ± 56	45 ± 56	48 ± 42
Dialysate(g)	22 ± 62	13 ± 62	13 ± 58
Starch(g)	83 ± 16	80 ± 15	78 ± 9
Crude fiber(g)	3.6 ± 1.5	4.5 ± 1.8	6.4 ± 2.3
Dietary fiber(g)	13 ± 5	16 ± 6	24 ± 7
Ascorbic acid(mg)	85 ± 50	91 ± 55	82 ± 63
Thiamin (mg)	1.08 ± 0.25	1.32 ± 0.58	1.71 ± 0.59
Riboflavin(mg)	1.04 ± 0.18	1.05 ± 0.35	1.03 ± 0.29
Niacin(mg)	13.4 ± 4.2	15.3 ± 3.5	14.7 ± 3.2
Vitamin B_6(mg)	1.2 ± 0.5	1.3 ± 0.5	1.5 ± 0.58
Vitamin B_{12}(mcg)	3.0 ± 1.3	3.0 ± 0.7	10.1 ± 16.7
Folacin(mcg)	132 ± 33	139 ± 46	159 ± 36
Vitamin A(IU)	3871 ± 2325	4967 ± 1975	4800 ± 3305
Vitamin A(RE)	704 ± 332	736 ± 251	760 ± 394
Vitamin D(IU)	112 ± 60	221 ± 60	223 ± 69
Calcium(mg)	481 ± 102	434 ± 128	463 ± 195
Phosphorus(mg)	852 ± 160	895 ± 245	1116 ± 352
Iron(mg)	10.8 ± 2.6	11.1 ± 3.4	14.3 ± 3.9
Sodium(mg)	1777 ± 334	1322 ± 180	1498 ± 365
Potassium(mg)	1832 ± 618	2001 ± 537	2425 ± 706
Zinc(mg)	7.0 ± 1.5	7.4 ± 2.1	9.4 ± 3.0

[1] one patient died

[2] mean ± standard deviation

* SFA = saturated fatty acids, MFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids

**P/S = polyunsaturated to saturated fatty acid ratio

For the females, energy intakes were similar to those reported for the general population in Canada and the United States (USDA 1980). However, during the baseline period the following mean intakes were below the recommended levels: niacin, folacin, vitamin A, calcium and zinc. Niacin intake was 93% of recommended, folacin, 69%; vitamin A,88%; calcium,60%; and zinc, 88%. Intakes of protein and vitamin B_6 were also below the levels considered to be adequate for the kidney patient. Energy intakes and nutrient intakes increased as the study progressed.

Average values in general obscure the range in individual intakes. Table 2.21 shows a prediction of the risk of inadequate intake. These estimates are based on data for the healthy population and very likely underestimate the probability of true deficiencies in a group of patients with kidney disease. The intake of many nutrients would appear to be inadequate with the predicted deficiencies decreasing during diet periods I and II. The consumption of vitamin and mineral supplements reduced the incidence of inadequacies for a few nutrients. However, inadequacies of intakes of zinc, calcium, vitamin A, vitamin B_{12} and protein were not decreased by the use of supplements. For a few vitamins the total intake from food plus supplement was over 1000% of the recommended level.

Table 2.22 presents the mean nutrient intakes per

TABLE 2.21
Mean per cent risk that observed intake is below requirement for three study periods

	Baseline		Period I		Period II	
	without supplements	with supplements	without supplements	with supplements	without supplements	with supplements
	n=12		n=11		n=10	
	%	%	%	%	%	%
Protein	10	10	2	2	1	1
Thiamin	3	0	6	0	0	0
Riboflavin	7	0	12	0	10	0
Niacin	15	0	6	0	5	0
Folacin	67	0	52	0	31	0
Vitamin B_{12}	4	4	7	7	7	7
Vitamin B_6	1	0	0	0	0	0
Vitamin C	31	0	6	0	13	0
Vitamin A	44	44	39	39	33	33
Vitamin D	11	11	0	0	0	0
Calcium	65	58	69	55	57	45
Iron	5	0	1	0	0	0
Zinc	36	36	25	25	7	7

TABLE 2.22
Mean daily dietary intake expressed as nutrient densities (per 1000 kilocalories)

	Baseline M n=6 F n=6	Period I M n=5 F n=6	Period II M n=5 F n=5
Protein (g)			
M	42	43	45
F	38	40	39
Thiamin (mg)			
M	0.77	1.29	0.98
F	0.72	0.87	1.03
Riboflavin (mg)			
M	0.90	0.82	0.81
F	0.70	0.70	0.62
Niacin (mg)			
M	10.1	10.5	11.0
F	9.0	10.1	8.9
Folacin (mcg)			
M	79	99	112
F	89	92	96
Vitamin B^{12} (mcg)			
M	2.7	2.8	3.8
F	2.0	2.0	6.1
Vitamin B_6 (mg)			
M	0.8	0.9	1.0
F	0.8	0.9	0.9
Vitamin C (mg)			
M	39	59	52
F	57	60	49
Vitamin A (RE)			
M	712	735	319
F	472	487	458
Vitamin D (IU)			
M	107	162	169
F	75	146	134
Calcium (mg)			
M	387	361	370
F	323	287	279
Iron (mg)			
M	7.7	8.4	9.2
F	7.2	7.4	8.6
Zinc (mg)			
M	5.1	5.1	6.1
F	4.7	4.9	5.7
Dietary fiber (g)			
M	7	10	14
F	9	11	14

1000 kilocalories (nutrient densities). The data collected show that the nutrient density for folacin was low in the males; for calcium it was low in the females. For the kidney patient whose caloric intake may be low, foods must be carefully selected to obtain a high nutrient density. There was a marked improvement in nutrient density during diet periods I and II especially for folacin, zinc , thiamin and fiber. For the males, nutrient density for thiamin improved from 0.77 mg/1000 kilocalories in the baseline period to 1.29 in diet period I and 0.98 in diet period II. For the females, nutrient density for thiamin improved from 0.72 mg/1000 kilocalories in the baseline period to 0.87 in diet period I and 1.03 in diet period II. Nutrient density for folacin improved noticeably throughout the study. For the males, folacin density increased from 79 mcg/1000 kilocalories in the baseline period to 99 and 112 in the modified diet periods. For the females, folacin density increased from 89 mcg/1000 kilocalories in the baseline period to 92 and 96 in the modified diet periods. For the males, the improvement in folacin intake meant that they could meet the recommended amount per 1000 kilocalories (94 mcg). Vitamin B_6 density increased throughout the study but there was little impact on protein density. Zinc density increased throughout the study: for the males it increased from 5.1 mg/1000 kilocalories to 6.1 mg/1000 kilocalories in period II; for the females zinc

density increased from 4.7 to 4.9 and 5.7 mg/1000 kilocalories.

6.2 Sources of nutrients

The food intakes were assessed in terms of food groups. The average quantities of food consumed in each category appear in Tables 2.23 and 2.24. The average total weight of food consumed by patients was low in comparison to the average Canadian, but an improvement was noted throughout the study. In periods I and II sugar-containing food items decreased notably. This resulted from counselling patients to choose energy sources from more nutrient-dense foods that had less effect on serum triglyceride levels. Total energy intake per day improved throughout the study; for males from 1652 to 1674 to 1744 kilocalories; for females from 1491 to 1510 to 1661 kilocalories. Protein intake also improved throughout the study as follows: for males from 70 to 72 to 78 grams per day; for females from 57 to 60 to 65 grams per day.

Meats and dairy products are of special importance for their nutritional contribution. However, for the kidney patient, there is a restriction on the intake of these foods. The cereal group can make a significant contribution to the diet, especially if whole grains are consumed. Table 2.25 shows the contribution of cereal

TABLE 2.23
Mean daily intake of food groups: Males

Food groups[1]	Control n=6		Period 1 n=5		Period 2 n=5		Nutrition Canada[2]	
	Mean intake (g)	% of total intake (%)	Mean intake (g)	% of total intake (%)	Mean intake (g)	% of total intake (%)	Mean intake (g)	% of total intake (%)
MFPE[3]	158 ± 35	13	155 ± 49	12	171 ± 41	14	211	14
Dairy products	216 ± 132	19	256 ± 184	20	240 ± 161	20	332	22
Cereal products	260 ± 110	22	222 ± 57	18	224 ± 49	18	269	18
(refined)	(173) ± 76	(15)	(144) ± 48	(11)	(80) ± 46	(6)		
(unrefined)	(87) ± 94	(8)	(78) ± 75	(6)	(144) ± 33	(12)		
Fruit products	180 ± 56	16	261 ± 124	21	210 ± 127	17	194	13
Vegetables	196 ± 170	17	195 ± 37	15	223 ± 48	18	265	17
Fats and oils	20 ± 16	2	37 ± 16	3	37 ± 18	3	29	2
Nuts	3 ± 7	-	9 ± 6	1	12 ± 16	1	15	-
Foods primarily sugar	20 ± 14	2	15 ± 23	1	6 ± 5	-	56	4
Other	104 ± 137	9	111 ± 85	9	107 ± 103	9	150	10
TOTAL	1159 ± 314	100	1261 ± 216	100	1231 ± 211	100	1521	100

[1]Categories described in Food Consumption Patterns Report; a report from Nutrition Canada, 1976

[2]Males 40 to 64 years of age

[3]Meat, poultry, fish, eggs

TABLE 2.24
Mean daily intake of food groups: Females

Food groups[1]	Baseline n=6		Period I n=6		Period 2 n=5		Nutrition Canada[2]	
	Mean intake (g)	% of total intake (%)	Mean intake (g)	% of total intake (%)	Mean intake (g)	% of total intake (%)	Mean intake (g)	% of total intake (%)
MFPE[3]	131 ± 29	14	139 ± 32	14	124 ± 44	16	145	12
Dairy products	124 ± 69	14	153 ± 90	15	154 ± 119	13	225	19
Cereal products	151 ± 44	17	114 ± 34	11	141 ± 33	14	174	15
(refined)	(114) ± 55	(13)	(82) ± 36	(8)	(41) ± 28	(4)		
(unrefined)	(37) ± 25	(4)	(32) ± 24	(3)	(100) ± 38	(10)		
Fruit products	221 ± 138	24	275 ± 170	27	267 ± 172	26	239	21
Vegetables	206 ± 101	23	260 ± 121	26	194 ± 109	20	215	19
Fats and oils	20 ± 7	2	34 ± 16	3	39 ± 15	4	20	2
Nuts	0	0	14 ± 15	1	28 ± 25	3	10	1
Foods primarily sugar	13 ± 7	2	2 ± 4	-	5 ± 7	-	39	3
Other	40 ± 38	4	24 ± 33	3	40 ± 77	4	89	8
TOTAL	906 ± 258	100	1015 ± 272	100	991 ± 278	100	1156	100

[1]Categories described in Food Consumption Patterns Report; a report from Nutrition Canada, 1976

[2]Females 40 to 64 years of age

[3]Meat, poultry, fish, eggs

TABLE 2.25
Contribution of cereal products to nutrient intakes

	Baseline		Period I		Period II	
	M n=6	F n=6	M n=5	F n=6	M n=5	F n=5
Grams of cereal products						
	260	151	222	114	224	141
refined	173	114	144	82	80	41
unrefined	87	37	78	32	144	100
Energy kcal	524	411	471	312	538	436
Protein(g)	14	13	14	10	19	16
Dietary fiber(g)	5	5	7	5	15	13
Thiamin(mg)	0.60	0.48	0.86	0.48	0.77	0.84
Vitamin B_6 (mg)	0.2	0.1	0.2	0.1	0.3	0.3
Folacin (mcg)	45	45	63	36	78	65
Vitamin A (IU)	473	116	60	0	74	0
Zinc (mg)	1.8	1.5	1.7	1.0	3.1	2.7
Iron (mg)	5.1	4.2	5.9	3.4	7.4	4.4
Vitamin B_{12} (mcg)	0.38	0.06	0.05	0.06	0.07	0

products to nutrient intake. During diet period II, the increased emphasis on whole grain cereals resulted not only in an increase in fiber intake but also an increase in the intake of many other nutrients. In addition, whole grain cereals are of special importance as a good source of many trace elements we do not routinely assess. Diet counselling improved the overall quality of the diet in addition to altering the quality of fat and carbohydrate consumed. One major difference in the intake of diet periods I and II, compared to the intake of the baseline period, was that the nutrients were obtained from a greater variety of foods.

7. Relation between dietary intake and parameters of health status

Presented in Table 2.26 are Pearson correlation coefficients comparing serum lipid data with selected micronutrient intake parameters in the three study periods. A significant positive correlation was noted between the per cent risk of dietary zinc deficiency and serum triglyceride levels. A significant negative correlation was noted between the per cent risk of folacin deficiency and serum HDL-cholesterol levels. It should be noted that these patients were heavily supplemented with folacin and the level of total folacin intake (food and

TABLE 2.26
Pearson correlation coefficients: mean serum lipid levels vs. mean dietary micronutrient levels in the three study periods[1]

Variable	Serum triglyceride	Serum cholesterol			
		total	VLDL	LDL	HDL
Dietary zinc - % risk of deficiency	+0.448*	+0.137	+0.437	+0.186	-0.377
Dietary folacin - % risk of deficiency	+0.396	+0.037	+0.391	+0.102	-0.455*[2]

[1] Based on data for 12 subjects, 3 study periods

[2] Correlation coefficient significant

* $p < 0.01$

TABLE 2.27
Pearson correlation coefficients: "at risk" nutrients (energy, protein, folacin, zinc) vs. dietary parameters

Variable	Energy kcal	Protein g	Folacin % risk	Zinc % risk
Energy (kcal)		+0.783**[1]	-0.482*	-0.543*
Protein (g)	+0.783**		-0.488*	-0.626**
Carbohydrate (g)	+0.793**			
Fat (g)	+0.873**	+0.769**	-0.475*	-0.566**
Vitamin B_6 (mg)	+0.727**	+0.803**	-0.689**	-0.552**
Folacin % risk	-0.482*	-0.488*		+0.590**
Riboflavin % risk		-0.623**		+0.623**
Niacin % risk		-0.583**		+0.591**
Ascorbic acid % risk			+0.492*	
Vitamin A % risk	-0.582**	-0.624**	+0.685**	
Zinc % risk	-0.543*	-0.626**	+0.590**	
Calcium % risk	-0.580**	-0.610**		

[1] Correlation coefficient significant

*p <0.01

**p <0.001

TABLE 2.28
Correlations of biochemical/dietary indices which achieved statistical significance

Correlation	Correlation coefficient	Significance level (p)
Serum creatinine vs. % risk of folacin deficiency	+0.491	<0.01
Hemoglobin vs. dietary protein (g/day)	+0.456	<0.01
Hemoglobin vs. % risk of calcium deficiency	-0.459	<0.01
Hemoglobin vs. % risk of riboflavin deficiency	-0.503	<0.01
Serum calcium vs. % risk of folacin deficiency	+0.470	<0.01
Serum albumin vs. dietary carbohydrate (g/day)	-0.601	<0.001
Serum albumin vs. dietary energy (kcal)	-0.556	<0.001

supplement) was over 2000% of RNI throughout the study. However, folacin occurs along with other essential nutrients in foods and it was noted that the folacin density of the diet improved during the study. Folacin is an indicator of the general quality of the diet.

The interrleationships between different nutrients in the diets was investigated further. Table 2.27 presents Pearson correlation coefficients comparing the nutrients that appear to be of importance for the kidney patient (energy, protein, folacin, zinc) and many dietary parameters. Daily dietary intake of nutrients is expressed both quantitatively and as % risk of nutrient deficiency. Significant negative correlations were noted between the % risk of folacin deficiency and energy intake ($p < 0.01$), protein intake ($p < 0.01$), fat intake ($p < 0.01$) and vitamin B_6 intake ($p < 0.001$). Significant positive correlations were noted between the % risk of folacin deficiency and the % risk of vitamin C deficiency, % risk of Vitamin A deficiency and % risk of zinc deficiency. Protein intake showed highly significant correlations with most of the dietary parameters evaluated. Animal protein is an excellent source of many essential vitamins and inorganic elements.

Relationships between dietary and biochemical parameters were also investigated. Table 2.28 presents correlations of biochemical/dietary parameters which achieved statistical significance. A positive correlation

was found between serum creatinine level and % risk of folacin deficinecy ($p < 0.01$) and between serum calcium levels and % risk of folacin deficiency ($p < 0.01$). A significant positive correlation was noted between dietary protein intake and hemoglobin levels ($p < 0.01$). Significant negative correlations were noted between hemoglobin levels and % risk of calcium and riboflavin deficiency ($p < 0.01$); significant negative correlations were also noted between serum albumin levels and energy intake ($p < 0.001$), and carbohydrate intake ($p < 0.001$).

The principal findings regarding nutrient intake and its effect on health status as revealed in this study are as follows (shown on Tables 2.15, 2.18, 2.26, 2.28):

- energy intake was correlated with HDL-cholesterol ($r = +0.463$; $p < 0.01$)
- energy intake vs. serum albumin ($r = -0.556$; $p < 0.001$)
- carbohydrate intake vs. serum albumin ($r = -0.601$; $p < 0.001$)
- sugar vs. serum total cholesterol ($r = +0.781$; $p < 0.001$)
- sugar vs. serum LDL-cholesterol ($r = +0.688$; $p < 0.001$)
- starch vs. serum total cholesterol ($r = -0.482$; $p < 0.01$)

- dietary fiber vs. serum triglyceride (r= -0.476; p<0.01)
- dietary fiber vs. serum VLDL-cholesterol (r= -0.446; p < 0.01)
- protein intake vs. hemoglobin level (r=+0.456; p< 0.01)
- % risk of calcium deficiency vs. hemoglobin (r= -0.459; p< 0.01)
- % risk of riboflavin deficiency vs. hemoglobin (r= -0.503; p< 0.01)
- % risk of folacin deficiency vs. serum creatinine (r= +0.491; 0 <0.01)
- % risk of folacin deficiency vs. serum HDL-cholesterol (r= -0.455; p< 0.01)
- % risk of folacin deficiency vs. serum calcium (r= +0.470; p< 0.01)
- % risk of zinc deficiency vs. serum triglyceride (r= +0.448; p<0.01)

DISCUSSION

In general, the diets were well accepted by the patients. All subjects completed the study, except one female who died before its conclusion. At the outset of the modified diet period I (fat-modified diet) some had difficulty consuming the prescribed quantities of margarine and vegetable oil. After discussing ways to use the items, however, there was less of a problem. The use of nuts and seeds was readily accepted by some who continued to use them throughout the study without constant encouragement. The regular use of sugar-reduced products was well accepted by all patients. There was reluctance to bring protein intake up to the desired level, but it did increase from an average of 0.9 gram per kg to 1.1 grams per kg during the study.

The combined fiber- and fat-modified diet (diet period II) was also well accepted and tolerated. The patients appreciated that the purchase of special products was not necessary; the increased quantity of dietary fiber was obtained from readily available foods. Good use was made of both the high-fiber recipes provided and the suggestions for ways of incorporating oat bran into the diet. Several patients indicated that they were able to decrease or discontinue their daily use of laxatives while on this regime. Dietary fiber intake increased from

11 grams per day in the baseline period to 16 and 25 grams per day in modified diet periods I and II. This is not a large increase, considering that the average fiber intake of the British population has been estimated at 20 grams per day (Bingham 1979).

The major emphasis of the modified diets was on the type of fat and carbohydrate consumed but improving the quality of the diets in other respects was also encouraged.

After completion of the study, one patient wished to remain on the study diet stating that she preferred the exchange type of system to other forms of diet sheets. She also stated that she felt better on the diets than she had prior to the study. One male, who had to discontinue his diet several times because of peritonitis, stated that he felt better during the periods when he was able to follow his individualized meal plan.

Four-day diet records were used for the quantitative assessment of dietary intake. In long-term studies, diet records make possible the collection of sufficient data on each individual to obtain nutrient values representative of the subject's usual intake. For each patient we obtained a total of 44 days of dietary intake data, far more than is usual in studies of this type. One dietitian collected all the data and reviewed them with the patients to minimize errors of omission. Poor estimation of serving portions and incomplete collection of data are the

major sources of error in diet record methodology.

The patients successfully modified their usual diets to alter the fat composition (increased P/S ratio and decreased cholesterol) and the carbohydrate composition (increased fiber-containing foods). Although we planned to alter the distribution of kilocalories so that energy from fat was 40%, from carbohydrate 45% and from protein 15%, we found that throughout the study the energy distribution of the baseline period was maintained. In the baseline period, energy from fat averaged 33%; from carbohydrate 51% and from protein 16%.

By modifying the fat content of the diet the P/S ratio of 0.4 of the baseline period was increased significantly ($p<0.001$) to 1.5 in diet period I and 1.7 in diet period II. Inadvertently, the diet counselling in diet period I resulted in an increased dietary fiber intake as well as a modification of the quality of fat consumed. However, the increase in dietary fiber intake from 12 grams in the baseline period to 16 grams in diet period I was not significant; it resulted mainly from an improvement in the intake of fruits and vegetables. In diet period II, the combined fiber- and fat-modified diet, mean dietary fiber intake increased to 24 grams per day ($p <0.01$) The additional fiber was derived largely from cereal products including whole grain products and oat bran.

In this study the fat-modified diet caused a

significant reduction in the serum triglyceride level ($p < 0.05$) and total and LDL serum cholesterol levels ($p < 0.01$; $p < 0.05$). The decreases in the mean levels of triglycerides, total cholesterol, LDL-cholesterol and VLDL- cholesterol were 26%, 14%, 16% and 25% respectively. In this study the fat-modified diet resulted in the most pronounced lipid lowering effect and yet we found no correlations between the lipid components of the diet and serum lipid levels. This problem has been encountered many times before and was recently discussed by Liu et al (1978). They suggest that intra-individual variations have a marked effect and that there is a combined effect of dietary saturated and polyunsaturated fatty acids on serum cholesterol. In this study we attempted to obtain representative figures for dietary intake and serum lipid levels; estimations for each period were based on dietary intakes for twelve days and two determinations for serum lipids. The statistical method we used for testing differences in lipid levels between the three study periods, the analysis of paired differences, is considered to be appropriate when there is a high degree of patient to patient variability.

The combined fiber- and fat-modified diet was effective in lowering serum lipids. It further decreased the lipids to obtain total reductions of 31% for triglycerides, 18% for total cholesterol, 20% for LDL-cholesterol and 29% for VLDL-cholesterol. It is

unlikely that this is merely a carry over effect from period I. Albrink (1986) found that there was no carry over effect on serum triglyceride levels and that for serum cholesterol the effect was gone by day four and for HDL levels by day eight. This reflects the longer turnover time of HDL and LDL than VLDL. In this study each period was three months in length and the results should not be affected by a carry over effect from period I to period II.

To date, dietary treatment of hypertriglyceridemia of patients undergoing maintenance dialysis has focused on the restriction of carbohydrate (Sanfelippo 1978, Cattran 1980). We were sucessful in lowering triglycerides using a more normal distribution of calories (the carbohydrate intake was 46 to 51% of kilocalories). However, both the amount of carbohydrate and the type of carbohydrate are important. We emphasized complex carbohydrate from grains and cereals, fruits and vegetables. Complex carbohydrates are generally found to reduce serum lipid levels but the specific effects are yet to be defined. Jenkins (1985) successfully lowered serum triglycerides and total and LDL serum cholesterol by modifying cereal products in the diet to lower the glycemic index (used rye breads, oat bran, bulgur, beans, barley, spaghetti). Dietary fiber intake was 23 grams per day. In our study the use of unrefined cereal products was encouraged, especially in period II. Cereal intake was altered as follows: the majority of

intake was from refined products in the baseline and period I, whereas the majority was from unrefined products in period II. The level of dietary fiber increased at the same time from 11 g in the baseline period to 16 g in period I and 24 g in period II. The sources of fiber in period II were: cereal products 56%, vegetables 19%, fruit 18% and nuts 7%. Dietary fiber includes polysaccharides such as pectic substances, vegetable gums, hemicelluloses, cellulose and the non-carbohydrate lignin. We obtained significant negative correlations between dietary fiber and serum triglycerides ($p < 0.01$), dietary fiber and serum VLDL-cholesterol ($p < 0.01$) and between starch and serum [illegible] cholesterol ($p < 0.01$).

Calories from sugar are particularly important for patients undergoing continuous ambulatory peritoneal dialysis because they absorb glucose from the dialysate solution several times a day. The glucose concentrations of the dialysate solutions vary from 1.50 to 4.25% depending on whether or not it is necessary to control fluid accumulation and/or elevated blood pressure. We found that glucose from the dialysate solution contributed from 63 to 464 kilocalories per day. In general the CAPD patients had higher blood lipid levels than the HEMO patients. We found a significant positive correlation between sugar and serum total cholesterol levels ($p < 0.001$) and between sugar and LDL-cholesterol levels

(p <0.001). McGandy et al (1966) reported that serum cholesterol levels were slightly higher during a sugar-rich diet than when starch was substituted. The usual effect of high carbohydrate intakes is considered to be an increased incorporation of free fatty acids into plasma triglycerides and a decreased hydrolysis of triglycerides (Waterhouse 1964, Farquhar 1966). Albrink (1986) suggests that dietary fiber protects against the lipid elevation effects of sugar. However, Albrink was using high levels of fiber in the diet (86g). We found a significant negative correlation between fiber intake and serum triglyceride ($p < 0.01$) and between fiber intake and VLDL-cholesterol ($p < 0.01$).

Adequacy of energy and protein intake is essential if patients are to maintain nutritional homeostasis. In this study, energy and protein intakes improved during the nine-month period. For the females, energy intake increased from 1491 kilocalories (27 kcal/kg) per day in the baseline period to 1661 kilocalories (29 kcal/kg) per day in period II. For the females, mean protein intake increased from 57 grams per day (1.0 g/kg) in the baseline period to 65 grams per day (1.1 g/kg) in period II. For the group this level of intake is acceptable and is very similar to the intakes reported for 53 year old women in the US Nationwide Food Consumption survey 1977-78 (1522 kilocalories, 65 g protein). Unfortunately, the energy intakes of the males in the study were unusually low. For

the males, mean energy intake increased from 1652 kilocalories per day (22 kcal/kg) in the baseline period to 1744 kilocalories per day (24 kcal/kg) in period II. Mean protein intake increased from 70 grams per day 0.9 g/kg) in the baseline period to 78 grams per day (1.1 g/kg) in period II. These intakes are much lower than intakes reported for 54 year old men in the US Nationwide Food Consumption survey 1977-78; in this case mean energy intake was 2148 kilocalories and mean protein intake was 90 grams per day. Intakes recorded in our initial survey of dialysis patients were higher than the intakes of the males in the study. In the survey mean energy intake for the males was 2110 kilocalories, mean protein intake was 74 grams. The men in the study were not smaller or older than the men in the survey; our calculated energy allowances for both groups were very similar. However, illness was a factor. The men in the study experienced much illness, especially in period I, when illness affected five out of the six men. In fact for two men, both of whom had surgery (for one, a coronary bypass), energy intakes throughout the study were less than calculated basal requirements. Of course we may not have been able to adequately assess usual dietary intake because of the illnesses. It is also possible that some of these men have adapted to an energy deficit over a longer period of time. On the other hand, we may have included in the study, men with true deficiencies of

intakes compared with requirements. However, illness among dialysis patients is not unusual; for the CAPD patients peritonitis is a well documented problem. The intakes we have documented may indicate the difficulties in maintaining adequate dietary intakes when appetite is poor and energy and protein needs may be higher than usual because of hypercatabolism.

In this study, we found a positive correlation between protein intake and hemoglobin levels ($p < 0.01$). In addition, hemoglobin level was corrleated with % risk of riboflavin deficiency ($p < 0.01$) and with % risk of calcium deficiency ($p < 0.01$). The correlation between protein intake and hemoglobin level is an important one; a relationship between protein intake and hemoglobin level has been noted by others (Hill 1977, Anonymous 1979). However, the effect of kidney disease on hemoglobin level must also be taken into account.

In this study we found that energy intake was correlated with several biochemical parameters; positive correlation between energy intake and serum HDL-cholesterol ($p < 0.01$); negative correlation between energy intake and serum albumin ($p < 0.001$). The relationship between energy intake and albumin level would have been expected to be positive however, energy intake, serum albumin levels and body weights fluctuated with illness.

The important finding was the extent to which there

were correlations between biochemical and clinical abnormalities and intakes of nutrients which were low relative to the majority of intakes of that nutrient. The results indicate that for some patients, poor dietary intake is contributing to clinical problems and poor health status. There are prospects of improvements in health by improving food intake. In this study, the following correlations suggest that improvements in nutritional status may result in improvements in the health of the patients:

- % risk of dietary folacin deficiency and serum creatinine (positive $p < 0.01$)
- % risk of dietary folacin deficiency and serum calcium (positive $p < 0.01$)
- % risk of dietary folacin deficiency and serum HDL-cholesterol (negative $p < 0.01$)
- % risk of dietary zinc deficiency and serum triglyceride (positive $p < 0.01$)

Folacin and zinc are two nutrients which appear to be commonly deficient in diets of the kidney patient undergoing maintenance dialysis. Folacin intake has been found to be a reliable indicator of the general quality of a diet. Folacin and zinc are not commonly evaluated but should be specifically ensured for nutritional adequacy. These nutrients occur in foods in combination with other essential nutrients, and what is more important, the ratios of nutrients in foods is usually more favourable

for optimal nutrient utilization than is the result when supplements are used (Solomons 1983, Rosenberg 1982). We must be cautious about creating nutrient imbalances. Interactions between nutrients can alter their availability with the result that a seemingly adequate intake may not meet the needs.

The relationships between dietary intake of these patients and parameters of health status suggest that close monitoring of food intake is warranted. We have picked out four nutrients ("at risk" nutrients) we have found to be at greatest risk in this study: energy, protein, zinc and folacin. Diets of patients undergoing maintenance dialysis do not contain foods and nutrients in the same proportions as consumed by the population as a whole. We have found that carbohydrates, if chosen wisely, have an important contribution to make to the total diet of the patient (Symposium 1985).

This study has indicated that dietary manipulation, aimed at modifying the quality of fat and carbohydrate consumed but without major alteration in the macronutrient content, may result in decreases in serum triglyceride and serum cholesterol. The dietary changes provide a nutritionally adequate diet and, unlike those made in previous studies, can be achieved by the free-living patient maintained on dialysis.

CONCLUSIONS

1. Two lipid-lowering diets were tested on twelve hyperlipidemic patients undergoing maintenance dialysis. One was a fat-modified diet, the other a combined fiber- and fat-modified diet. Dietary manipulation resulted in a significant reduction in serum triglyceride and total, VLDL and LDL cholesterol by comparison with the mean lipid values for the baseline period.

2. Modification of the quality of fat was achieved by substituting oils and margarines of high P/S value for more saturated fat in the diet. The P/S ratio of the diet was increased from 0.4 in the baseline period to 1.5 with the fat-modified diet and 1.7 with the combined fiber- and fat-modified diet. Cholesterol intake was decreased to less than 300 mg per day.

3. Modification of the quality of carbohydrate was achieved by substituting whole grains for more refined cereal products and by increasing the intake of friuts and vegetables. The dietary fiber content of the diet was increased from 12 grams in the baseline period to 16 grams with the fat-modified diet and 24 grams with the combined fiber- and fat-modified diet. This is

still not an unusually high intake for a free-living individual.

4. The distribution of Calories varied very little throughout the study. Calories from fat were 33 to 37%, carbohydrate, 46 to 51% and protein 16 to 17%. The distribution of Calories is similar to that of the diet of the average Canadian.

5. A significant amount of sugar is absorbed from the dialysate solution when patients undergo continuous ambulatory peritoneal dialysis. In this study, glucose in the dialysate contributed 63 to 464 kilocalories per day. Significant positive correlations were found between sugar and serum total cholesterol level ($p < 0.001$) and between sugar and LDL-cholesterol levels ($p < 0.001$).

6. Modification of the quality of fat and carbohydrate in the diets of patients undergoing dialysis is acceptable and well within the framework of usual food habits. Diet modification may be useful in controlling blood lipid levels ; it has the potential to reduce the risk of accelerated cardiovascular disease.

7. Significant negative correlations were found between

dietary fiber and serum triglycerides ($p < 0.01$), dietary fiber and serum VLDL-cholesterol ($p < 0.01$) and between dietary starch and serum total cholesterol ($p < 0.01$).

8. A major problem for the patients studied was low intake of protein and Calories, especially with illness such as peritonitis and surgery. Reduced food intake was associated with decreased intake of many nutrients including zinc and folacin.

9. Poor dietary intake probably contributes to poor health status for some of the patients in the study. Many significant correlations were found between nutrient intake and biochemical parameters including:
protein intake vs. hemoglobin ($r = +0.456$; $p < 0.01$)
energy intake vs HDL-cholesterol ($r = +0.463$; $p < 0.01$)
% risk of dietary folacin deficiency and serum creatinine ($r = +0.491$; $p < 0.01$)
% risk of dietary folacin deficiency and serum calcium ($r = +0.470$; $p < 0.01$)
% risk of dietary folacin deficiency and HDL-cholesterol ($r = -0.455$; $p < 0.01$)
% risk of dietary zinc deficiency and serum triglyceride ($r = +0.448$; $p < 0.01$)

10. The nutrient density of the diet was increased with

diet counselling that focused on regulating the intake of many nutrients on an individual basis without overly restricting food choices.

11. Dialysis patients are at high risk of nutritional deficiencies. An important objective of nutritional management is to achieve a high ratio of nutrients to Calories.

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Appendix 1: Consent form

CLINICAL INVESTIGATION CONSENT FORM

TITLE OF RESEARCH PROJECT: A study to examine the effect of dietary treatment on blood lipid levels.

EXPLANATION OF PROJECT:

Patients undergoing peritoneal dialysis have elevated levels of lipids, or fatty substances, in their blood. These high lipid levels contribute to atherosclerosis, which leads to heart and blood vessel disease. The purpose of the study is to find out which of two diets is more effective in controlling high blood lipid levels.

The study will last for nine months. For the first three-month period you will be interviewed by a dietitian to obtain information about your food intake. For the next six months you will be placed on two special diets; the effect of each of these diets will be studied for a three-month period. One diet will be a fat-modified diet; the other diet will be a combined fat- and fiber-modified diet. You will receive regular diet counselling from a dietitian. We will regularly interview and perform lab tests on all subjects in the study.

My physician, Dr. _____, has explained to me that I will be interviewed by a dietitian each month when I visit the hospital. In addition, the dietitian will be helping me to modify my food intake. I will be involved in the study for approximately nine months. The dietary treatment may not necessarily have beneficial results but on the other hand it will not have harmful side effects. I will receive the best available supportive medical care throughout the study. Four extra blood tests will be performed so that blood lipid levels can be followed.

I certify that the procedures described to me, and any questions that I have asked, have been answered to my satisfaction. I have been informed of alternatives to participation in this study and understand that I have no obligation to consent to enter this study and that I will still receive the best available medical care if I do not consent.

. . . 2

I understand also that I am free to withdraw from the study at any time. I have been assured that records relating to me and to my care will be kept confidential and that no information will be released or printed that would expose my personal identity without my permission.

I have read and understand the above information and hereby consent to participate in the study.

Patient's Signature

Signature of Investigator

Witness

Date

Appendix 2: Four-day dietary record form

4 DAY FOOD RECORD

PATIENT _____

DIETITIAN Janie Sanderson

PHONE - 432-4925

FACULTY OF HOME ECONOMICS
UNIVERSITY OF ALBERTA

INSTRUCTIONS

Please use the following sheets to record everything that you eat or drink for the specified 4 days. Eat as you normally would if [illegible] keeping this record. We suggest that you write the [illegible] down while eating or just after you finish eating since [illegible] difficult to recall in detail later.

At the top of each page please write the date of the day for which you are providing the information. Use as many of the following pages as you need to record your meals. In the first column list the time of day the food or beverage was consumed. In the second column list the amount consumed as a volume, weight, number of pieces etc. Whenever possible copy the portion size or the appropriate portion eaten from cans, bottles, and packages.

For the food description please give us as many details as possible and also the brand names of commercial products. Please record the method of preparation for example, raw, baked, boiled etc. and whether the item was fresh, canned, or frozen. Please record any additions such as salt, sugar, butter or gravy. If you eat a casserole, stew or other mixed dishes we would be very grateful if you could include the recipe on the blank pages at the back and remember to record how much of the whole recipe you actually consumed for example, one half, one third etc.

Remember to record all snacks, gum, candy, alcoholic or other beverages, cough drops, vitamin or mineral supplements and the amount that you consumed during these 4 days.

Some examples of incorrect and correct recording are shown on

the following pages. When you are writing your food record imagine that someone wants to duplicate your meals as closely as possible.

Thank you for participating in this study.

CORRECT METHOD OF COMPLETING A 4 DAY FOOD RECORD

Date June 5th

Time of Day	Amount	Description
7 am	2 slices	toasted white bread
	3 Tbsp	Kraft Strawberry jam
	6 oz	perked coffee
	1 tsp	sugar
	2 Tbsp	homo milk
12:15	½ 10oz can	Campbell's chicken noodle soup
	1 slice	rye bread
	3"x3"x¼" slice	baked ham
	1 Tbsp	mayonnaise
	3-2" diameter	Oreo cookies
630 pm	1	hamburger bun
	3"widex1"thick	broiled beef patty
	1 8oz cup	frozen peas boiled
	1-6"	banana
	4oz	2% milk
10:30 pm	6oz	tea
	2 -3"square	unsalted soda crackers
	2" x 1" x ¼"	slice cheddar cheese

INCORRECT METHOD OF COMPLETING A 4 DAY FOOD RECORD

Time of Day	Amount	Description
7 am	2 slices	Toast and jam
	1 cup	coffee
12:15 pm	1 bowl	Chicken noodle soup
	½	ham sandwich
	3	cookies
6:30 pm	1	hamburger
	1 serving	peas
	1	banana
	½ glass	milk
10:30	1cup	tea
	2	crackers
	1 slice	cheese

4 DAY FOOD RECORD NAME_____

DATE _____

TIME OF DAY	AMOUNT	DESCRIPTION

Appendix 3: Terminology - diet modifications

SOME QUESTIONS AND ANSWERS ABOUT YOUR CONTROLLED FAT DIET

1. Why do I need to be on a special diet?

Your tests have shown that you have high levels of fat in your blood stream. Research has suggested that when these high levels are found there is an increased possibility that you may develop heart disease. The two types of fat that we are concerned about are called triglyceride and cholesterol. We would like to see if the blood levels of these fats can be lowered by changing your diet.

2. What are triglycerides?

Triglycerides are a type of fat found in many foods and also in your blood. We all have a certain amount of triglyceride in our blood but CAPD patients tend to have very high levels of this fat. Persistently elevated triglycerides are not desirable.

3. What is cholesterol?

Cholesterol is another type of fat normally found in your blood stream and in all your body cells. Some foods contain a lot of cholesterol and will be allowed only in limited amounts. Persistently elevated cholesterol levels are also not desirable.

4. What are polyunsaturated fats?

These fats are desirable in your diet. They are mainly found in foods of plant origin and they are usually liquid at room temperature. Examples are corn oil, sunflower seed oil, safflower oil and products made from these oils such as special margerines. Research suggests that increasing the polyunsaturated fats in the diet helps to lower high triglyceride/cholesterol levels.

5. What are saturated fats?

This type of fat is found mainly in foods of animal origin, for example, butter, cream, homogenized milk, cheese, beef and pork. A few fats from plant sources are also saturated fats including palm oil, coconut, coconut oil and cocoa butter. Saturated fats in the diet tend to increase blood triglyceride/cholesterol levels so foods containing saturated fats will only be allowed in limited amounts.

6. Can my family follow this diet too?

Yes. The whole family can eat the foods which you are allowed on your diet. The quantities they eat may differ somewhat.

7. Should I take vitamins or minerals?

Continue to take the vitamins and minerals your doctor has prescribed. DO NOT change the amounts taken unless he tells you to do so. Additional vitamins and minerals above what he has prescribed are not necessary.

8. Why is my diet called a "controlled fat" diet?

Because we want to increase the amount of polyunsaturated fats and decrease the amount of saturated fat in your diet, you will be instructed to eat specific amounts and types of fats and oils each day. In this way we will be "controlling" your dietary intake of fat.

Appendix 4: [illegible]ge lists - fat-modified diet for CAPD patients

MEAL PLAN AND FOOD GROUPS

NAME _____

DIETITIAN - Janie Sanderson
Phone 432-4925
or
432- 5031

Please bring all of these sheets to all 6 week CAPD appointments. If you are admitted to the hospital take these sheets with you and ask to speak to the Dietitian as soon as possible.

NAME

DATE

Calories
gCHO
gPRO
gFAT
Fib
gChol
gFiber

MEAL PLAN

MEAL	FOOD GROUP	NUMBER OF SERVINGS
BREAKFAST	HIGH PROTEIN FOODS	
	CEREALS	
	STARCHY FOODS	
	FAT	
	FRUIT	
	MILK	
	FREE FOODS	
MORNING SNACK		
LUNCH	HIGH PROTEIN FOODS	
	STARCHY FOODS	
	FAT	
	VEGETABLES	
	FRUIT	
	MILK	

FOOD GROUP 1 - HIGH PROTEIN FOODS

ONE SERVING of a HIGH PROTEIN FOOD is equal to one choice of the following:

WEIGH ALL MEATS WITHOUT BONE AFTER COOKING	AMOUNT TO EAT FOR 1 SERVING
Veal - leg, loin, rib, shank, shoulder, cutlets	1 ounce
Poultry - chicken, turkey, cornish hen AVOID ALL SKIN ON POULTRY	1 ounce
Fish - any fresh or frozen fish	1 ounce
- canned salmon, tuna, crab, lobster - all well drained	¼ cup
Beef - lean beef, chuck, flank steak, tenderloin, round rump, ground lean	1 ounce
Pork - leg, *ham, loin chop if well trimmed before cooking	1 ounce
Lamb - leg, sirloin, loin roast, chop (trim well before cooking), shank, shoulder	1 ounce
Cheese - *# low fat processed cheese	1 ounce
- * cottage cheese	¼ cup
Eggs - limit of 3 per week	1 medium
Egg Substitutes - eg. Eggbeaters	¼ cup
*# Peanut butter	2 tablespoons

* Limit to 1 ounce per day due to the high salt content

See lists page 7 for allowed brands to use

FOOD GROUP 2 - CEREALS

ONE SERVING of CEREAL is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
Ready- to-eat unsweetened cereal	3/4 cup
Hot cooked cereals	½cup

FOOD GROUP 3 - STARCHY FOODS

ONE SERVING of STARCHY FOOD is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
Bread - white, brown, rye, whole wheat, French, Italian, pumpernickel, cracked wheat	1 slice
Bagel	½
English Muffin	½
Plain small roll	1
Hot dog bun	½
Hamburger bun	½
Rice, barley (cooked)	½ cup
Noodles (cooked)- macaroni, spaghetti, lasagna	½ cup
Flour - white, whole wheat, cracked wheat	2½ tablespoons
Popcorn - popped without fat	2 cups
Crackers:	
2"Soda crackers - preferably unsalted	4
Saltines - preferably unsalted	6
Graham crackers	2 squares
Cookies:	
Arrowroot	3
Social teas	4
Angel Food cake	1½" slice
White Potatoes - boiled, baked, roasted	1 small
- mashed	½ cup
Corn - Niblets	1/3 cup
- cob	one 5" cob
Soup -*canned or homemade vegetable, chicken rice chicken noodle, turkey noodle etc. AVOID all cream soups unless homemade with skim milk	1 cup

*limit to 1 cup per day due to high salt content

3.

FOOD GROUP 4 - FAT

ONE SERVING of FAT is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
FAT A	
Sunflower oil	1 teaspoon
Corn oil	1 teaspoon
Walnuts - unsalted, unroasted only	5 halves
Sunflower seed kernels - raw or dry roasted only - unsalted only	1 tablespoon
FAT B	
*Special soft margarine	1 teaspoon
Pecans - unsalted, unroasted	5 halves

* See lists page 7 for allowed brands to use

4.

NOTE - Avoid canned vegetables due to high salt content

FOOD GROUP - 5 VEGETABLES

ONE SERVING of VEGETABLES is equal to one choice of the following:

GROUP A	AMOUNT TO EAT FOR 1 SERVING
Beets	½ cup
Broccoli	4 stalks
Brussel sprouts	½ cup
carrots	½ cup
Green peas	½ cup
Onion	1 medium
Squash	½ cup
Turnip	½ cup
Mixed vegetables	½ cup

NOTE - see Food Group 3 for potato and corn

GROUP B

The following vegetables may be taken as desired in reasonable quantities.

Lettuce
Cabbage
Celery
Cucumber
Green pepper
Bean sprouts
Green or wax beans
Green onion
Cauliflower
Mushrooms
Spinach
Zucchini
Radishes
Water cress
Raw tomato
Canned tomato
Tomato juice
Vegetable cocktail
Parsley

FOOD GROUP 6 - FRUIT

ONE SERVING of FRUIT is equal to one choice of the following:
ALL FRUIT IS FRESH, FROZEN OR CANNED WITHOUT ADDED SUGAR.
If friut is canned in juice or diet packed in a small amount of sugar, measure as below but avoid juice.

	AMOUNT TO EAT FOR 1 SERVING
Apple - juice	1/3 cup
- raw	1 small
- applesauce	½ cup
Apricots - fresh	2
- canned	4 halves + 2 Tbsp juice
Banana	3inches
Berries - strawberries	½ cup
- raspberries	½ cup
- saskatoons	½ cup
Cherries	½ cup
Fruit cocktail or fruit salad	½ cup
Grapefruit - fresh	½ small fruit
- juice	½ cup
Grapes	12
Melon - canteloupe, honeydew	½ medium melon
- watermelon	1 cup cubes
Nectarine	1 medium
Orange - fresh	1 medium
- juice	½ cup
Peach - fresh	1 medium
- canned	2 halves + 2 Tbsp juice
Pear - fresh	1 small
- canned	2 halves + 2 Tbsp juice
Pineapple - fresh	½ cup cubes
- canned	½ cup + 2 Tbsp juic
Plums - fresh	2 medium
- canned	2 medium + 2 Tbsp juice
Rhubarb - raw	2 cups
- stewed without sugar	1 cup
Tangerine	1 medium

FOOD GROUP 7 - MILK

ONE serving of MILK is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
Liquid _____ milk	½ cup
Skim milk powder (dry)	1/3 cup
Canned evaporated skim milk	¼ cup
Buttermilk made from skim milk	½ cup
Plain skim or 2% milk yogurt	½ cup

FOOD GROUP 8 - FREE FOODS

These foods may be taken as desired without measuring.

Flavouring extracts
Spices and herbes - avoid onion, garlic and celery salts
vinegar
cocoa powder
Lemon, lime juice or wedge
Diet fruit spreads

Trident Gum and mints

The following foods are calorically free but must be restricted within your fluid allowance.

water
ice cubes
soft drinks sweetened with aspartame
clear tea and coffee
artificially sweetened jelly powder

THE FOLLOWING FOODS MUST BE AVOIDED ON YOUR CONTROLLED FAT DIET:

MILK AND MILK PRODUCTS

homogenized milk
chocolate milk
sweetened condensed milk
eggnog
malted milk
milkshakes
fruit flavoured yogurt
any yogurt with fat content greater than 2%
ice cream , sherbet
ice milk
dietetic ice cream
coffee cream, cereal cream
half and half, whipping cream
sour cream

CHEESE - All natural cheeses must be avoided. You will be given a list of allowed processed cheeses and cottage cheeses

BREADS, CEREALS AND OTHER STARCHY FOODS

All commercial baked goods unless made with the allowed oils.
Commercial cake, pastry and cookie mixes.
Cereals containing coconut or coconut oil or palm oil .
Sugar coated cereals
Commercial french fries
egg noodles
cream soups
potato chips, corn chips, pretzels etc.

MEAT, FISH, POULTRY

Processed meats - sausages, weiners, luncheon cold cuts (ham is allowed)
Organ meats - liver, kidney, heart, tongue, brain
Duck, goose, skin on poultry
Shrimp
Side bacon, spare ribs and all other cuts of heavily marbled or fatty meats

FATS AND OILS

butter
lard
shortening
drippings
palm oil
regular and calorie-reduced salad dressings
mayonnaise
Miracle Whip
coconut oil

PEANUT BUTTER
Some peanut butters must be avoided. You will be given a list of allowed brands.

NUTS

cashews, pistac[illegible]
All nuts roasted in palm or coconut oils

FRUITS

All fruits or juices canned, bottled or frozen with added sugar.

VEGETABLES

Avoid vegetables served with butter, cheese or sauce of any kind.

MISCELLANEOUS

regular, sugar-sweetened pop
gravy
sweet pickles
hot chocolate, Ovaltine
jello dessert
white sugar, brown sugar, honey, molasses, table syrups
jams, jellies, marmalade
ALL candy, chocolate
powdered or liquid coffee whiteners
ALL ALCOHOL

Appendix 5: Exchange lists - fat-modified diet for HEMO patients

lists modified for HEMO patients (other lists as for CAPD patients)

MEAL PLAN AND FOOD GROUPS

NAME _____

DIETITIAN - Janie Sanderson

Phone 432-4925

or

432- 5031

Please bring all of these sheets to all hemo clinic appointments. If you are admitted to the hospital take these sheets with you and ask to speak to the Dietitian as soon as possible.

FOOD GROUP 2 - CEREALS

ONE SERVING of CEREAL is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
Ready- to-eat unsweetened cereal	3/4 cup
Hot cooked cereals	½cup

FOOD GROUP 3 - STARCHY FOODS

ONE SERVING of STARCHY FOOD is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
Bread - white, brown, rye, whole wheat, French, Italian, pumpernickel, cracked wheat	1 slice
Bagel	½
English Muffin	½
Plain small roll	1
Hot dog bun	½
Hamburger bun	½
Rice, barley (cooked)	½ cup
Noodles (cooked)- macaroni, spaghetti, lasagna	½ cup
Flour - white, whole wheat, cracked wheat	2½ tablespoons
Popcorn - popped without fat	2 cups
Crackers:	
2"Soda crackers - unsalted only	4
Saltines - unsalted only	6
Graham crackers	2 squares
Cookies:	
Arrowroot	3
Social teas	4
Angel Food cake	1½" slice
White Potatoes - double boiled	1 small
- mashed	½ cup
Corn - Niblets	1/3 cup
- cob	one 5" cob
Soup - low sodium vegetable, chicken rice chicken noodle, turkey noodle etc. AVOID all cream soups unless homemade with skim milk	1 cup

FOOD GROUP - 5 VEGETABLES

ONE SERVING of VEGETABLES is equal to one choice of the following

GROUP A

Beets	1/2 cup
Cooked broccoli	4 stalks
Cooked carrots	1/2 cup
Green peas	1/2 cup
onion	1 medium
Turnip	1/2 cup
Mixed vegetables	1/2 cup

NOTE - see Food Group 3 for potatoes and corn

GROUP B

The following vegetables may be taken as desired in reasonable quantities

Lettuce
Cabbage
Cucumber
Green Pepper
Bean sprouts
Green or wax beans
Green onion
Zucchini
Radishes
Water cress
Parsley

5

FOOD GROUP - 5 - FRUIT

ONE SERVING of FRUIT is equal to one choice of the following. All fruit is fresh, frozen or canned in fruit juice or water without added sugar. Aylmer Diet Deluxe brand canned fruits may be used which contain a very small amount of sugar.

	AMOUNT TO EAT FOR 1 SERVING
Apple - juice	1/3 cup
- raw	1 small
- unsweetened applesauce	1/2 cup
Berries - strawberries	1/2 cup
- raspberries	1/2 cup
- saskatoons	1/2 cup
- blueberries	1/2 cup
Cherries	1/2 cup
Grapefruit - fresh	1/2 small fruit
- juice	1/2 cup
Grapes	12
Watermelon	1 cup cubes
Peaches - fresh	1 small
- special canned	2 halves no juice
Pears - fresh	1 small
- special canned	2 halves no juice
Pineapple - fresh	1/2 cup cubes
- special canned	1/2 cup no juice
Prune plums	2 medium
Red plums	1 medium
Rhubarb - raw	1 cup
- stewed without sugar	1/2 cup
Tangerine	1 medium
Manderin orange - fresh	1 medium
- special canned	1/2 cup

Appendix 6: Suggestions: ways to use oil

SUGGESTIONS FOR USING OIL IN YOUR DIET

1. Frying high protein or other foods. Be sure to use all oil remaining in pan.
2. Mix with crumbs for crumb coating.
3. To cook vegetables - Place oil in skillet with measured serving of vegetables. Season if desired, cover and cook over very low heat stirring occasionally until done. A little water may be added during cooking if needed.
4. As a marinade for cooked vegetable salad. eg. left-over peas and carrots - season with oil and herbs and lemon juice or special mayonnaise thinned with a little oil.
5. In whipped potatoes, scalloped potatoes or other mashed vegetables such as squash or turnip.
6. Mix into hot cereal.
7. To fry eggs or Eggbeaters.
8. To pop corn.
9. To fry cooked rice - add green peas, chopped green onion and herbs.
10. To season all salads.

Appendix 7: Recipes for fat-modified diets

RECIPES (CAPD)

OIL AND VINEGAR DRESSING

Yield - 1 1/4 cups.
Use 1 Tablespoon as 2 servings of Fat A.

Ingredients:
- 1 teaspoon salt
- 1/2 teaspoon pepper
- 1/2 teaspoon celery seed
- 1/4 teaspoon dry mustard
- 2 tablespoons wine vinegar
- 2 tablespoons tomato juice
- 1/4 teaspoon tabasco sauce
- 1 cup corn or sunflower oil - allowed brands only
- 1 clove garlic

Method: Combine ingredients in jar. Cover and shake to blend.

LEMON DRESSING

Yield - 1 cup.
Use 1 Tablespoon as 2 servings Fat A.

Ingredients:
- 2/3 cup corn or sunflower oil
- 1/2 cup fresh squeezed lemon juice
- 1/4 teaspoon sugar
- 1/4 teaspoon dry mustard
- 1/4 teaspoon freshly ground black pepper
- 1 garlic clove
- 1/2 teaspoon salt

Method: Place all ingredients in a screw-top jar and shake vigorously until blended. Remove garlic after a few days. The dressing will keep about 1 month.

Variations: Add 1 teaspoon of one of the following or mix them to your taste - fresh basil, tarragon, chives, parsley, coriander, marjoram, thyme.

QUICK MAYONNAISE

Use 1 Tablespoon as 3 Fat A.

Ingredients:
1 teaspoon sugar
speck of cayenne
1/4 teaspoon dry mustard
1 teaspoon salt
1 tablespoon lemon juice
1 tablespoon vinegar
1 egg unbeaten
1 cup corn or sunflower oil

Method: Add juice of lemon and vinegar to dry ingredients and mix thoroughly.
Add egg but do not beat.
Add 1/3 of oil (chilled in frig) and beat until mixture begins to thicken.
Add another 1/3 cup of oil and beat and then add rest of oil and beat until thick.

SPICE COOKIES

Yield - 4 dozen

Use 1 cookie as 1 serving Starchy Food plus 1 serving Fat A

Ingredients

1 egg white
2/3 cup corn or sunflower oil - allowed brands only
½ cup brown sugar
3/4 cup white sugar
½ cup water
5 cups all purpose flour
1 tablespoon baking powder
½ teaspoon salt
1 tablespoon ground ginger
1 teaspoon cinnamon
1 teaspoon cloves

Method:

Beat egg white slightly, add oil, both sugars and water and mix thoroughly. Sift together dry ingredients. Fold into first mixture until flour is moistened. Drop dough from teaspoons onto lightly oiled cookie sheet. Flatten slightly with back of spoon. Bake at 375° for 10-12 min. or until browned on bottom .

APRICOT NUT BREAD

Yield - 30 slices

Use 1 slice as 1 serving starchy food

INGREDIENTS

2½ cups all purpose flour
1 cup sugar
1 tablespoon plus ½ teaspoon baking powder
½ teaspoon salt
3 tablespoons corn or sunflower oil
½ cup skim milk
2 egg whites
1/4 cup orange juice
4 teaspoons orange peel
1/4 cup chopped pecans
10 large dried apricot halves chopped

Heat oven to 350°. Grease and flour a 9 x 5 x 3 inch loaf pan or two 8½ x 4½ x 2½ inch pans. Measure all ingredients into large mixer bowl. Beat on medium speed one half minute, scraping bowl constantly. Pour into pan(s). Bake 35-45 min or until pick inserted in centre comes out clean. Remove from pan after 5 minutes. Cool thoroughly before slicing and serving.

BUTTERMILK MUFFINS

Yield - 12

Eat 1 muffin as one serving starchy food and one serving fat A

INGREDIENTS

2 egg whites
1 cup buttermilk
1/4 cup corn or sunflower oil
2 cups all purpose flour
1/4 cup sugar
2 teaspoons baking powder
1/2 teaspoon baking soda
1/2 teaspoon salt

Heat oven to 400°. Thoroughly mix flour, sugar, baking powder, soda, and salt. Form a well and add egg white, buttermilk and oil. Stir only til dry ingredients are moistened. Fill muffin tins 2/3 full. Bake 25 minutes or until well done.

VARIATIONS

Blueberry - Add 3/4 cup fresh or frozen unsweetened blueberries to batter. Mix lightly. Bake as directed.

Raisin - Add 1/2 cup raisins to batter, 1/2 teaspoon cinnamon may be added also if desired. Bake as directed.

PUMPKIN BREAD

Yield - 20 slices

Eat 1 slice as one serving starchy food and one half serving fat A

INGREDIENTS

1 cup flour
1 teaspoon soda
1/2 teaspoon salt
1/2 teaspoon cinnamon
1/2 teaspoon nutmeg
1/2 teaspoon allspice
1/2 cup sugar
2 tablespoons corn or sunflower oil
2 egg whites beaten til frothy
2 tablespoons water
2/3 cup canned pumpkin
3 tablespoons chopped pecans
1/3 cup chopped dates

Heat oven to 350°. Combine all ingredients and mix well. Pour into a small loaf pan and bake for one hour. Bread will slice better if served the following day.

Recipes (Hemo)

OIL AND VINEGAR DRESSING

Yield - 1 1/4 cups

Use 1 tablespoon as 2 servings fat A

INGREDIENTS

1 teaspoon salt
1/2 teaspoon pepper
1/2 teaspoon celery seed
1/4 teaspoon dry mustard
2 tablespoons wine vinegar
2 tablespoons tomato juice
1/4 teaspoon tobasco sauce
1 cup corn or sunflower oil - allowed brands only
1 clove garlic

Combine ingredients in a jar. Cover and shake to blend.

LEMON DRESSING

Yield one cup

Use 1 tablespoon as 2 servings fat A

INGREDIENTS

2/3 cup corn or sunflower oil
1/2 cup freshly squeezed lemon juice
1/4 teaspoon dry mustard
1/4 teaspoon freshly ground black pepper
1 garlic clove

Place all ingredients in a screw-top jar and skake vigorously until blended. Remove garlic after a few days. Dressing will keep about 1 month.

Variations - Add 1 teaspoon of one of the following or mix them to your taste. - fresh basil, tarragon, chives, parsley, coriander, marjoram, thyme

QUICK MAYONNAISE

Use 1 tablespoon as 3 fat A

INGREDIENTS

1 teaspoon sugar
speck of cayenne
1/4 teaspoon dry mustard
1 teaspoon salt
1 tablespoon lemon juice
1 tablespoon vinegar
1 egg unbeaten
1 cup corn or sunflower oil

Add juice of lemon and vinegar to dry ingredients and mix thoroughly. Add egg but do not beat. Add 1/3 of oil (chilled in frig) and beat until mixture begins to thicken. Add another 1/3 cup of oil and beat and then add rest of oil and beat until thick.

BUTTERMILK MUFFINS

yield - 12

Eat 1 muffin as one serving starchy food and one serving fat A.

INGREDIENTS

2 egg whites
1 cup buttermilk
1/4 cup corn or sunflower oil
2 cups all purpose flour
1/4 cup sugar
2 teaspoons baking powder
1/2 teaspoon baking soda
1/2 teaspoon salt

Heat oven to 400°. Thoroughly mix flour, sugar, baking powder, baking soda and salt. Form a well and add egg whites, buttermilk and oil. Stir only til dry ingredients are moistened. Fill muffin tins 2/3 full. Bake 25 minutes or until well done.

Appendix 8: Exchange lists for combined fiber- and fat-modified diet

for CAPD patients

MEAL PLAN AND FOOD GROUPS

NAME _____

DIETITIAN - Janie Sanderson
Phone 432-4925
or
432- 5031

Please bring all of these sheets to all 6 week CAPD appointments. If you are admitted to the hospital take these sheets with you and ask to speak to the Dietitian as soon as possible.

GENERAL INSTRUCTIONS FOR YOUR HIGH FIBER, CONTROLLED FAT DIET

For the next 3 months you will be continuing on your controlled fat diet and at the same time adding foods which are high in fiber to your diet. After you have been on the high fiber, controlled fat diet for 6 weeks your blood fat levels will be checked again to see whether or not adding the extra fiber to your diet has changed the blood fat levels.

You will notice that the list of starchy foods (food group3), has changed. For example, white bread is no longer listed and whole wheat and whole meal bread products have been added. This is because the whole grain breads and products contain much more fiber than does white bread or other white flour products. The whole grain breads and products then, are much more desirable in your diet for the next 3 months.

The fruit group has also changed. The fruit juices have been removed as they contain little or no fiber. The raw, fresh fruits contain a lot of fiber and so are desirable in your diet. The canned diet fruits may be taken occasionally but it is preferable for you to take the fresh fruits and to eat the skins and seeds. For example, the seeds and skins of grapes and apples contain alot of fiber and should be eaten.

The vegetable list (Food group 5) has not changed. Continue to take as many raw salad vegetables as possible and when you have cooked vegetables, eat the skins. For example, the skin on a boiled or baked potato has a great deal of valuable fiber and so it should be eaten rather than discarded. Do not peel carrots. Wash them clean and eat them raw or cooked. If you peel them you are needlessly discarding useful fiber. If you have cucumber or tomato eat all of the skins and seeds.

It is also necessary for you to use _____ of raw oat bran every day. It can be sprinkled on other cereals, on salads, over vegetables, over a dish of raw fruit etc. It may also be added to boiling water and taken as a hot cereal. Note that the oat bran must be taken IN ADDITION to a serving of high fiber breakfast cereal every day.

1.

FOOD GROUP #1 - HIGH PROTEIN FOODS

ONE SERVING FOR A HIGH PROTEIN FOOD is equal to one choice of the following:

WEIGH ALL MEATS WITHOUT BONE AFTER COOKING	AMOUNT TO EAT FOR 1 SERVING
Veal - leg, loin, rib, shank, shoulder, cutlets	1 ounce
Poultry - chicken, turkey, cornish hen AVOID ALL SKIN ON POULTRY	1 ounce
Fish - any fresh or frozen fish	1 ounce
- canned salmon, tuna, crab, lobster - all well drained	¼ cup
Beef - lean beef, chuck, flank steak, tenderloin, round rump, ground lean	1 ounce
Pork - leg, *ham, loin chop if well trimmed before cooking	1 ounce
Lamb - leg, sirloin, loin roast, chop (trim well before cooking), shank, shoulder	1 ounce
Cheese - *#low fat processed cheese	1 ounce
-*cottage cheese	¼ cup
Eggs - limit of 3 per week	1 medium
Egg Substitutes - eg. Eggbeaters	¼ cup
#Peanut butter	2 tablespoons

* Limit to 1 ounce per day due to the high salt content

See lists page 7 for allowed brands to use

FOOD GROUP 2 - CEREALS

ONE SERVING of CEREAL IS EQUAL TO ONE CHOICE OF THE FOLLOWING:

	AMOUNT TO EAT FOR 1 SERVING
All Bran	1/2 cup
Bran Buds	1/2 cup
Bran Flakes	3/4 cup
100% Bran cereal (Nabisco)	1/2 cup
Grape Nuts	1/2 cup
Grape Nuts Flakes	3/4 cup
Oatmeal (cooked)	1/2 cup
Puffed Wheat	3/4 cup
Shredded Wheat	1 biscuit
Muffets	1 biscuit
Spoon - Sized Shredded Wheat (not frosted)	1 cup
Corn Bran cereal	1/2 cup
Sunnyboy or Red River (cooked)	1/2 cup

FOOD GROUP 3 - STARCHY FOODS

ONE SERVING of STARCHY FOOD is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
Bread - 100% whole wheat or whole meal	1 slice
Plain small whole wheat or whole meal roll	1
Whole wheat hot dog or hamburg bun	1/2
Rice - brown rice only (cooked)	1/2 cup
Flour - whole wheat, cracked wheat	2 1/2 tablespoons
popcorn (popped)	2 cups
Weston Stoned Wheat Thins	3
Graham crackers	2 squares
McCormick's SunWheat cookies	2
White potatoes - eaten with skins	
- boiled, baked, roasted	1 small
- mashed	1/2 cup
Corn - Niblets	1/3 cup
- cob	one 5" cob
Soup - *canned or homemade vegetable, chicken rice chicken noodle, turkey noodle etc AVOID all cream soups unless homemade with skim milk	1 cup
Beans - kidney beans (cooked)	1/2 cup
- lima beans "	1/2 cup
- pinto beans "	1/2 cup
- white beans "	1/2 cup
- lentils "	1/2 cup
- lentils	

* limit to one cup per day due to high salt content

3.

FOOD GROUP 4 - FAT

ONE SERVING of FAT is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
FAT A	
Sunflower oil	1 teaspoon
Corn oil	1 teaspoon
Walnuts - unsalted, unroasted only	5 halves
Sunflower seed kernels - raw or dry roasted only - unsalted only	1 tablespoon
FAT B	
*Special soft margarine	1 teaspoon
Pecans - unsalted, unroasted	5 halves

* See lists page 7 for allowed brands to use

4.

NOTE - Avoid canned vegetables due to high salt content

FOOD GROUP - 5 VEGETABLES

ONE SERVING of VEGETABLES is equal to one choice of the following:

GROUP A	AMOUNT TO EAT FOR 1 SERVING
Beets	½ cup
Broccoli	4 stalks
Brussel sprouts	½ cup
carrots	½ cup
Green peas	½ cup
Onion	1 medium
Squash	½ cup
Turnip	½ cup
Mixed vegetables	½ cup

NOTE - see Food Group 3 for potato and corn

GROUP B

The following vegetables may be taken as desired in reasonable quantities.

Lettuce
Cabbage
Celery
Cucumber
Green pepper
Bean sprouts
Green or wax beans
Green onion
Cauliflower
Mushrooms
Spinach
Zucchini
Radishes
Water cress
Raw tomato
Canned tomato
Tomato juice
Vegetable cocktail
Parsley

FOOD GROUP 6 - FRUIT

ONE SERVING of FRUIT is equal to one choice of the following: All fruit should be taken without added sugar. If fruit is canned in juice or diet packed in a small amount of sugar measure as below but avoid juice.

	AMOUNT TO EAT FOR 1 SERVING
Apple - raw	1 small
- applesauce made with skins included	1/2 cup
Apricots - fresh	2
- diet canned	1/2 cup
Banana	3 inches
Berries - strawberries	1/2 cup
- raspberries	1/2 cup
- Saskatoons	1/2 cup
Cherries - fresh or diet canned	1/2 cup
Fresh fruit cocktail or fruit salad	1/2 cup
Grapefruit - fresh	1/2 small fruit
Grapes - fresh	12
Melon - canteloupe, honeydew	1/4 medium melon
- watermelon	1 cup cubes
Nectarine	1 medium
Orange - fresh	1 medium
Peach - fresh	1 medium
- diet canned	1/2 cup
Pear - fresh	1 small
- diet canned	2 halves
Pineapple - fresh	1/2 cup cubes
- diet canned or in juice	1/2 cup cubes
Plums - fresh	2 medium
- diet canned	2 medium
Prunes -	2
Mandarin orange	1 medium
Raisins	2 level tablespoo
Rhubarb - fresh	2 cups
- stewed without sugar	1 cup
Tangerine	1 medium

FOOD GROUP 7 - MILK

ONE serving of MILK is equal to one choice of the following:

	AMOUNT TO EAT FOR 1 SERVING
Liq[illegible] milk	½ cup
Skim milk powder (dry)	1/3 cup
Canned evaporated skim milk	½ cup
Buttermilk made from skim milk	½ cup
Plain skim or 2% milk yogurt	½ cup

FOOD GROUP 8 - FREE FOODS

These foods may be taken as desired without measuring.

Flavouring extracts
Spices and herbes - avoid onion, garlic and celery salts
vinegar
cocoa powder
Lemon, lime juice or wedge
Diet fruit spreads

Trident Gum and Mints

The following foods are calorically free but must be restricted within your fluid allowance.

water
ice cubes
soft drinks sweetened with aspartame
clear tea and coffee
artificially sweetened jelly powder

Appendix 8: Exchange lists modified for HEMO patients
(other lists same as for CAPD patients)

MEAL PLAN AND FOOD GROUPS

NAME _____

DIETITIAN - Janie Sanderson
Phone 432-4925
or
432- 5031

Please bring all of these sheets to all hemo clinic appointments.
If you are admitted to the hospital take these sheets with you and ask to speak to the Dietitian as soon as possible.

4.

FOOD GROUP - 5 VEGETABLES

ONE SERVING of VEGETABLES is equal to one choice of the following

GROUP A

Beets	1/2 cup
Cooked broccoli	4 stalks
Cooked carrots	1/2 cup
Green peas	1/2 cup
onion	1 medium
Turnip	1/2 cup
Mixed vegetables	1/2 cup

NOTE - see Food Group 3 for potatoes and corn

GROUP B

The following vegetables may be taken as desired in reasonable quantities

Lettuce
Cabbage
Cucumber
Green Pepper
Bean sprouts
Green or wax beans
Green onion
Zucchini
Radishes
Water cress
Parsley

**NOTE - the skins on vegetables contain a great deal of valuable fiber and therefore they should be eaten whenever possible whether the vegetable is eaten raw or cooked.

FOOD GROUP - 6 - FRUIT

ONE SERVING of FRUIT is equal to one choice of the following. All fruit is fresh, frozen or canned in fruit juice or water without added sugar. Aylmer Diet Deluxe brand canned fruits may be used which contain a very small amount of sugar.

	AMOUNT TO EAT FOR 1 SERVING
Apple - raw	1 small
- unsweetened applesauce-include skins	1/2 cup
Berries - strawberries	1/2 cup
- raspberries	1/2 cup
- saskatoons	1/2 cup
- blueberries	1/2 cup
Cherries	1/2 cup
Grapefruit - fresh	1/2 small fruit
Grapes	12
Watermelon	1 cup cubes
Peaches - fresh	1 small
- special canned	2 halves no juice
Pears - fresh	1 small
- special canned	2 halves no juice
Pineapple - fresh	1/2 cup cubes
- special canned	1/2 cup no juice
Prune plums	2 medium
Red plums	1 medium
Rhubarb - raw	1 cup
- stewed without sugar	1/2 cup
Tangerine	1 medium
Manderin orange - fresh	1 medium
- special canned	1/2 cup

**NOTE - Try to eat raw fruits whenever possible as they have much more fiber than canned fruits. The skin on the fruit is a good source of fiber and therefore it should be eaten whenever possible. eg. apples, peaches, pears etc. should not be peeled before eating.

Appendix 9: Suggestions: increasing fiber in diet

SUGGESTIONS FOR USING OAT BRAN IN YOUR DIET

1. One oat bran muffin can be substituted for:

   1 serving of starchy food and 1 fat B and 3 Tbsp oat bran

2. 2 oat bran cookies can be substituted for:

   1 serving starchy food and one fat B and 2 Tbsp oat bran

3. 1 spicy oatmeal cookie can be substituted for:

   1 serving starchy food and one fat A and 1 Tbsp oat bran

4. Sprinkle oat bran on salads along with the dressing

5. Mix oat bran into salad-type sandwich fillings such as egg salad, tuna salad, salmon etc.

6. Sprinkle oat bran over your serving of fruit eg. applesauce

7. Sprinkle oat bran into mashed vegetables eg. squash, turnip, potatoes etc.

8. Sprinkle oat bran over your serving of high fiber cereal

Appendix 10: Recipes for combined fiber- and fat-modified diet

HIGH FIBER RECIPES

OAT BRAN MUFFINS

yield - 1 dozen

Eat 1 muffin for 1 starchy food and 1 fat B plus 3 Tbsp Oat Bran

2 cups Oat Bran Cereal
1/3 cup all purpose flour
2 Tablespoons firmly packed brown sugar
1/4 cup walnuts
1/4 cup raisins
1 tablespoon baking powder
1/2 tsp salt
1/4 tsp cinnamon
1 cup skim milk
2 eggs beaten
1/3 cup mosasses
2 tbsp corn or sunflower oil

Heat oven to 425 degrees. Grease bottoms only of 12 muffin cups or line with paper baking cups. Combine dry ingredients. Add milk, eggs, molasses and oil. Mix just until dry ingredients are moistened. Fill muffin cups 3/4 full. Bake for 15-17 minutes or until golden.

OAT BRAN COOKIES

yield - 3 1/2 dozen

Eat 2 cookies as 1 serving starchy food and 1 fat B plus 2 tablespoons Oat Bran

3 1/4 cups Oat Bran Cereal
1 cup allpurpose flour
1 tsp soda
1/2 tsp salt
1/2 tsp cinnamon
1 cup brown sugar
1 cup special margarine
2 eggs
1/2 tsp vanilla
1/2 cup raisins

Heat oven to 350 degrees. Grease cookie sheet. In medium bowl, combine oat bran, flour, soda, salt and cinnamon. In large bowl beat together sugar, and margarine until light and fluffy. Blend in eggs and vanilla. Gradually add dry ingredients and mix well. Stir in raisins. Drop by well rounded teaspoonfuls onto cookie sheet. Bake 12-14 min. Remove from sheet and cool

SPICY APPLE OATMEAL COOKIES

yield - 40 cookies
Eat 1 cookie as one serving starchy food and 1 fat A plus 1 tablespoon Oat bran

INGREDIENTS

1/2 cup corn syrup
1/2 cup molasses
1 cup apple juice
2/3 cup corn or sunflower oil
2 1/2 cups whole wheat flour
1 1/2 teaspoons cinnamon
1/2 teaspoon nutmeg
1/4 teaspoon cloves
1/2 teaspoon salt
1 cup sunflower seeds
2 1/2 cups diced apple with skins
3 cups uncooked rolled oats

Heat oven to 350°. In a large bowl combine corn syrup, molasses, apple juice and oil. Stir until blended. In another bowl mix together the flour, spices and salt. Add the dry ingredients to the liquid one third at a time, blending well after each addition. Fold in the sunflower seeds and diced apples. Fold in the oatmeal. Drop batter by tablespoofuls onto oiled cookie sheet and bake 12-14 minutes or until done and lightly browned.

Appendix 11: Guidelines for suitable commercial products

PRODUCT LIST

The following brands ONLY may be used on your diet.

OILS

Safflo Sunflower Oil

West Sunflower Oil

Mazola Corn Oil

St. Lawrence Corn Oil

Woodward's Corn Oil

Town House Corn Oil

MARGARINES

Becel

Fleishman's Soft Corn Oil

Fleishman's Unsalted Corn Oil

Fleishman's Sunflower Seed Oil

Monarch Corn Oil

Monarch Soft

Achieve Soft Margerine

LOW FAT PROCESSED CHEESE

Maple Leaf Processed Skim Milk Slices
Ingersol Skim Milk Cheese Spread
Kraft Light and Lively processed Skim Milk Cheese - slices
- spread
- block cheese
Kraft Ricotta Benoit
Weight Watchers Processed Skim Milk Cheese slices
Lucerne Processed Skim Milk Cheese Slices
Black Diamond Lites Processed skim Milk Cheese slices

PEANUT BUTTER

Any brand of fresh ground peanut butter

Empress

Golden Valley

Appendix 12: Reminders to bring meal-provider for diet counselling

Dear _____

Just a reminder that you have a CAPD clinic appointment on _____ at _____ Please note that you do NOT need to be fasting for the blood tests that will be done on this visit. In other words, you may have your breakfast before you come in for your appointment. Please be prepared to spend about 1 hour with me to learn your new diet and if at all possible it is very important to have whoever does the majority of the cooking at home come with you if it is not yourself. Also, please remember to bring your completed 4 Day Food Record with you.

Thank you,
Janie Sanderson, Dietitian

Appendix 13: Letter of instruction to out-of-town labs drawing blood

To: Supervisor of Laboratory Services

As part of a research program studying renal dialysis patients, we would like to ask for your assistance in obtaining a blood serum sample from this patient. Because of the number of samples required and the distance many patients live from the University Hospital, we are asking laboratories near the patient's residence to draw the blood sample, spin it down, and send the serum sample to the University Hospital. Your assistance in obtaining 3 samples over the 9 month study is appreciated very much.

In order to standardize methodology as much as possible, the Department of Laboratory Medicine has requested the following:

(1) draw 5 ml of clotted blood in a red stoppered tube

(2) spin and separate the serum within 2 - 3 hours of its collection

(3) please note collection date and time on the attached requisition form

(4) send at least 1.5 ml of serum to: Department of Laboratory Medicine
University of Alberta Hospital
8440 - 112 St.
Edmonton, Alberta
T6G 2B7

Thank you very much for your assistance.

R.A. Ulan, M.D., F.R.C.P.(C)
Director of Renal Failure Programs
University of Alberta Hospital