patients will be 90 percent.

Thus, on the average it can be assumed that of the 29,000 new patients treated by chronic dialysis each year, about 14,500 will survive and 14,500 will not survive the first year of treatment. The 14,500 survivors (now depleted of the poorest risks) will subsequently have a 90 percent survival rate in the ensuing years. In addition, of the approximate 3,575 brought into the dialysis program each year after an initial unsuccessful attempt at transplantation, approximately 3,218 will survive the first year because they were derived from a strongly overlapping group of highly suitable patients for either treatment.

III. CALCULATION OF COSTS

A. Yearly Costs

It is obvious that the mere calculation of the cost of the first year of such a "total push" program would leave a misleading impression as to the true long-term expense involved if such an approach is chosen. Because of the significant rate of survival from year to year among the patients treated by chronic dialysis the cost of extending treatment to all those needing it in subsequent years will increase considerably with the passage of time. It was therefore decided to calculate the actual cost of the treatment of all individuals requiring it (the new group of vulnerable uremic patients presenting itself each year and the patients on lifelong dialysis who are survivors from previous years) for as many years as needed after the start of the program until a year was reached which could be considered characteristic of a "steady state." At this particular point in time the number of new patients included each year in this program would equal the number of patients

dying in the same year, and in this situation a constant or near-constant yearly cost of the program would be reached.

Calculations to find a year in which a steady state would be reached showed that under the conditions of this program its yearly cost would increase greatly each year during the first 15 years, that the subsequent yearly increases in cost would be of a somewhat lesser magnitude but still highly significant, and that an asymptotic curve approach would show that the steady state would not yet be reached by the twenty-fifth year. Obviously one can expect research advances to occur well within the first 10 or 15 years (provided that current Federal research support will not be diminished because of the institution of a "total push" treatment program) and that these advances would modify greatly the respective efficacies of transplantation and hemodialysis and their costs. It was therefore decided that it would be unrealistic to report the cost of the hypothetical total push treatment program for end-stage kidney disease in terms of the eventual yearly cost of the steady state after 25 years. Rather, it was felt that it would be sufficiently indicative of the true costs to be expected to report the cost of the first year of such a program (the lowest yearly cost), the cost of the fifth year (a realistically foreseeable sum which is not likely to be influenced significantly by changes in the state of the art), and the cost of the fifteenth year (which is considerably higher than the cost of the fifth year and begins to approach the markedly higher eventual cost of the steady state year).

Based on the conditions in II A and II B, above, the yearly costs for this program were calculated for each of the first 15 years. As expected, the total cost of this treatment program rose considerably and progressively with each year because of the significant carry-over, from the preceding years, of surviving patients on chronic dialysis.

B. Present and Future Per Capita Costs

To obtain a realistic range of cost the calculations were done on the basis of two cost assumptions for each treatment modality:

1) A "present cost" figure of $16,000 per patient for transplantation, and a "present cost" figure of $15,000 per year per patient for chronic dialysis. The latter figure reflects as accurately as possible the present cost of chronic dialysis in a specialized dialysis center setting. (Dialysis at home was not yet considered well enough developed to be proposed for this large population. Moreover, it was recognized that the majority of patients to be treated by dialysis did not have the proper home setting, a vigorous and capable spouse, or other family conditions which are a prerequisite for successful home dialysis).

In the case of transplantation, the cost of $16,000 includes all medical and surgical expenses for the year in which the transplantation takes place, such as the necessary preliminary dialysis regimen and tissue matching, the surgery and all postsurgical treatments--dialysis, immunosuppression, and others--averaged out per patient (since some patients would require more and some less of these after-treatments).

2) An estimated "future cost" figure for each treatment modality which should reflect the decrease in cost of these treatments due to the mass operation effect, such as cost decrements due to greater efficiency of a large scale, well organized operation in dialysis, and savings due to more efficient large scale organization of the necessary preoperative, operative and postoperative activities and treatments in the case of transplantation, including greater efficiency in matching available kidneys to a large tissue-typed panel of recipients. The "future cost" figure for transplantation was thus set at $12,000 per patient and, in the case of dialysis, at $10,000 per patient per year.

As has been mentioned before, this hypothetical program could not be started in the intended scale since neither the necessary facilities nor a sufficient number of specially trained (and willing) physicians, surgeons, and paramedical personnel is available. The present analysis is carried out, nevertheless, in order to delineate the costs one must expect for such a total push endeavor.

The "present cost" figures are considered here to hold true for the first year of this hypothetical program, and may continue to influence costs in the early years until the gradual, improved organization and integration of the evolving mass effort permit the eventual cost reductions foreseen. The considerably lower "future cost" figures would become representative progressively during the subsequent years. To allow for all possibilities, the cost of the various years is reported in terms of a range between the higher "present cost" figure and the lower "future cost" figure.

It was decided not to charge the cost of conservative treatment to this total push program on the basis that the nature of the expenses of conservative treatment are not much different from those of other semi-terminal and terminal disease conditions, and that such costs would therefore not be borne by the Federal Government.

IV. RESULTS

The following results were obtained on the basis of the previously explained assumptions and calculations:

A. First Year

Based on "present cost" figures, the cost of treating 40,000 patients out of the total vulnerable population of 50,000 during the first year of this hypothetical program, by means of chronic dialysis or kidney transplantation, would be $611,000,000.

Note: If an attempt is made to treat all 50,000 vulnerable patients, the cost of this program during the first year will be $761,000,000.

If the calculation for the first year is based on the less likely "future cost" rate, the respective figures would be $422,000,000 and $522,000,000.

B. Fifth Year

The cost of this program in the fifth year of its existence will range between $1,043,600,000 (based on the low, "future cost" figure) and $1,543,415,000 (based on the higher, "present cost" figure). In this year, 102,161 patients will be treated under the program by transplantation or chronic dialysis.

C. Fifteenth Year

The cost of this program in the 15th year of its existence will range between $1,816,000,000 (based on the low "future cost" figure) and $2,702,000,000 (based on the higher "present cost" figure). In this year, 179,401 patients will be treated under this program, by transplantation or chronic dialysis.

In view of the fact that it is anticipated that research advances evolving during and after the first fifteen years of the program would introduce considerable improvements into both treatment modalities and would influence true costs significantly, projected expenses for the twentieth and twenty-fifth year of the program are not given. It should be noted, however, that the population which would require treatment during each year of this program will continue to grow and thus the yearly costs will increase, until a point beyond the twenty-fifth year at which a steady state will be reached.

V. DISCUSSION

The cost figures cited in the foregoing section are likely to be discouraging to any but the most determined advocates of a total push program. In reality, however, other factors which are more compelling than dollars are even more important in consideration of attempts at large scale treatment of end-stage kidney failure. Among these are 1) the nature of the population of 50,000 who present themselves each year with end-stage kidney failure, 2) the availability of trained and qualified physicians for the dialysis component of such a program, and of surgeons and physicians for its transplantation component, 3) the availability of the necessary competent and well-trained paramedical staff, and 4) the availability of necessary facilities for large scale chronic dialysis, be it in a hospital setting or in specialized dialysis centers associated with existing hospitals.

Assuming that one well-trained and willing physician is necessary for every 10 to 20 patients in a chronic dialysis program, the treatment of 40,000 patients would require the availability of 2-4,000 physicians for such an organized effort. The financial inducement would have to be high enough to attract this number of physicians to a new type of special medical activity which, on the whole, appears less attractive to most well-trained men because of the expected limitations and monotony of the treatment of a single, circumscribed disease condition.

The training of specialized paramedical personnel in sufficient quantities may possibly represent less of a problem although, here too, we face the spectre of robbing Peter to pay Paul--of withdrawing significant numbers of veteran nurses from a field of action which is already badly undermanned at present.

In either case, acquisition of the necessary new personnel could only come about very gradually over a period of several years.

Provided that the necessary funds are available, construction,acquisition and organization of relevant facilities may not be as forbidding a problem as that of personnel; here too, however, considerable lead time will be required until all the necessary facilities would be ready for operation.

The greatest obstacle to a total push attempt at treating all of the 50,000 yearly patients in chronic progressive renal failure is the medical nature of this group. About three-quarters of this group are known to be above the age of 60. A large proportion have many other concurrent disorders (chronic heart disease, advanced atherosclerosis, hypertension, diabetes, and others) which make them poor risks for kidney transplantation and less than optimal patients for chronic dialysis. In addition, chronic dialysis, to be successful, places large demands on the patient for emotional stability, and experience has shown that only a portion of those who are medically suitable for chronic dialysis possess the necessary emotional (or minimal intellectual) prerequisites.

VI. FEASIBLE APPROACHES FOR END-STAGE KIDNEY DISEASE TREATMENT

The elements for the planning of feasible approaches for end-stage kidney disease treatment are contained in Chapter 5, which details hypothetical programs for dealing with the problem of treatment for end-stage kidney failure. For the purposes in Chapter 5, the assumption was made, in these programs, that there had been no problem in recruiting the necessary medical and paramedical staff, and that the necessary facilities and funding were available. Every one of these problems exists, however, and limits the speed in which either the "intermediate level" or "accelerated level" programs can be translated into reality. Thus, any feasible program for the near future must be envisioned within the confines of the following existing restraints:

About 6,000 to 8,000 individuals in chronic renal failure are ideally suited for chronic dialysis. About a similar number of patients are assumed generally to be well suited for kidney transplantation. About 6,000 individuals in each of these groups overlap (i.e. about 2,000 individuals in each of these groups is ideally suited for one treatment modality but not for the other). Most patients suitable for either procedure are within the 15 to 54 age group. Since it is self-evident that a number of years is required for the training and organization of facilities for a large scale chronic dialysis program, only the most suitable patients can be considered as serious candidates for such a program in the near future. In the case of transplantation, the availability of matching kidneys for the suitable patients in the group of patients maintained by chronic dialysis will determine the actual number of transplants attempted. Thus the total number of individuals involved in a program feasible for

activation within the next few years will probably be in the neighborhood of 8,000 and certainly not more than 10,000.

For the chronic dialysis component of the program, a conservative assumption should be made, based on present experience, that in the beginning about one physician, two nurses and three to four technicians and aides would be required for every ten patients. This means that a going program for 8,000 patients would require 800 specialized physicians, 1600 specially trained nurses, and 4,000 specially trained technicians and aides. Because of this heavy demand for personnel the first year of such a program probably could not accommodate more than 800 new patients. Additional patients would have to be admitted to the program as additional personnel is trained and becomes available.

Since it appears that personnel is more of a critical factor than facilities, the availability of personnel (rather than facilities) is more likely to govern the number of patients included in this program during each of the subsequent years.

To reduce cost to a minimum, and based on experience obtained in dialysis centers and home dialysis programs thus far, it would probably be desirable to start new patients in full-time dialysis centers and to "graduate" subsequently those patients whose personality, family situation and home conditions are most suitable to home dialysis. Thus, eventually, the dialysis centers would harbor at any one time three types of patients: 1) new patients who are being stabilized and trained for home dialysis, 2) patients who have graduated from the center but who have gotten into trouble during home dialysis and who require, at this point, medically well supervised treatment, and 3) a hard core of patients who must be

dialyzed in a center setting since they or their family/home conditions are not conducive to home dialysis, or who have tried home dialysis and this attempt was not successful in the long run. In addition, at all times, each center would harbor a number of patients on a temporary basis who are having cannulae placed in their arteries and veins, or whose cannulae are being declotted, or who are suffering from other intercurrent disorders or complications.

Since the majority of dialysis patients would also be suitable candidates for transplantation an attempt would be made to transplant every patient for whom a matching kidney can be obtained. Thus, each center facility would embrace both treatment modalities and would consist of a combination of a chronic dialysis and dialysis training center, and a center for kidney transplantation and tissue matching activities. The transplantation staff would consist primarily of surgical teams and tissue matching laboratory staff; in addition, the internist/nephrologist staff responsible for the patients who are being dialyzed will serve for the medical backup of the transplantation staff.

With this general framework in mind and utilizing the elements and computations in Section V. of Chapter 5, it is possible to arrive at practical and feasible predictions concerning the cost of such a program and the overall number of patients which could be accommodated by it during each of the first few years, the number of patients who are likely to graduate from this program permanently each year because of successful transplantation, the number of individuals who would have to be maintained permanently with the aid of chronic dialysis, and the number of <u>new</u> patients which such a program could accommodate each year.

Assuming that the first year could not accommodate more than 800 patients, the subsequent yearly growth of this effort would depend on the availability of the necessary personnel. Thus, the number of years required until such a program could encompass 8,000 top (ideally suitable) candidates from among the 50,000 new vulnerable individuals each year, will depend on the availability of the requisite funds, manpower and facilities available for expansion.