

DR. ELI FRIEDMAN AND THE COMPACT TRAVEL DIALYSIS SYSTEM (SUITCASE KIDNEY)

Patients treated by maintenance hemodialysis are limited in mobility and rehabilitation by the need to conform to a schedule developed by their dialysis centers. Although the introduction of home hemodialysis has permitted great flexibility in scheduling daily activities, the patient is unable to be separated from a dialyzer for more than two or three days. Attempts by patients to overcome this impediment to travel has met with variable success. Group travel has, on occasion, been difficult to plan due to the impracticability of scheduling dialyses for a large number of patients at an already crowded center. Some units prohibit so-called "guest dialysis", especially for patients who are hepatitis antigen positive. For patients successful in obtaining placement in centers at their vacation location, the need to spend three mornings or afternoons per week devoted to dialysis diminishes full enjoyment of holiday time. The concept of a portable dialysis system to overcome the time stricture of center dialysis is not new. Patients have adapted existing "small" systems such as the Redy system, for travel, by placing them in vans or trailers. This alternative is generally not practical for most urban dialysis patients.

We have previously reported the combined effort at Downstate Medical Center and Kings County Hospital Center resulting in the Friedman-Hutchisson dialysis system designed for use in travel(1). Details of the system's specifications and components and initial clearance data obtained in in-hospital dialysis has been provided(1). We report herein our experience with three patients who actually used the compact system in travel, as well as more recent design innovations.

DESIGN

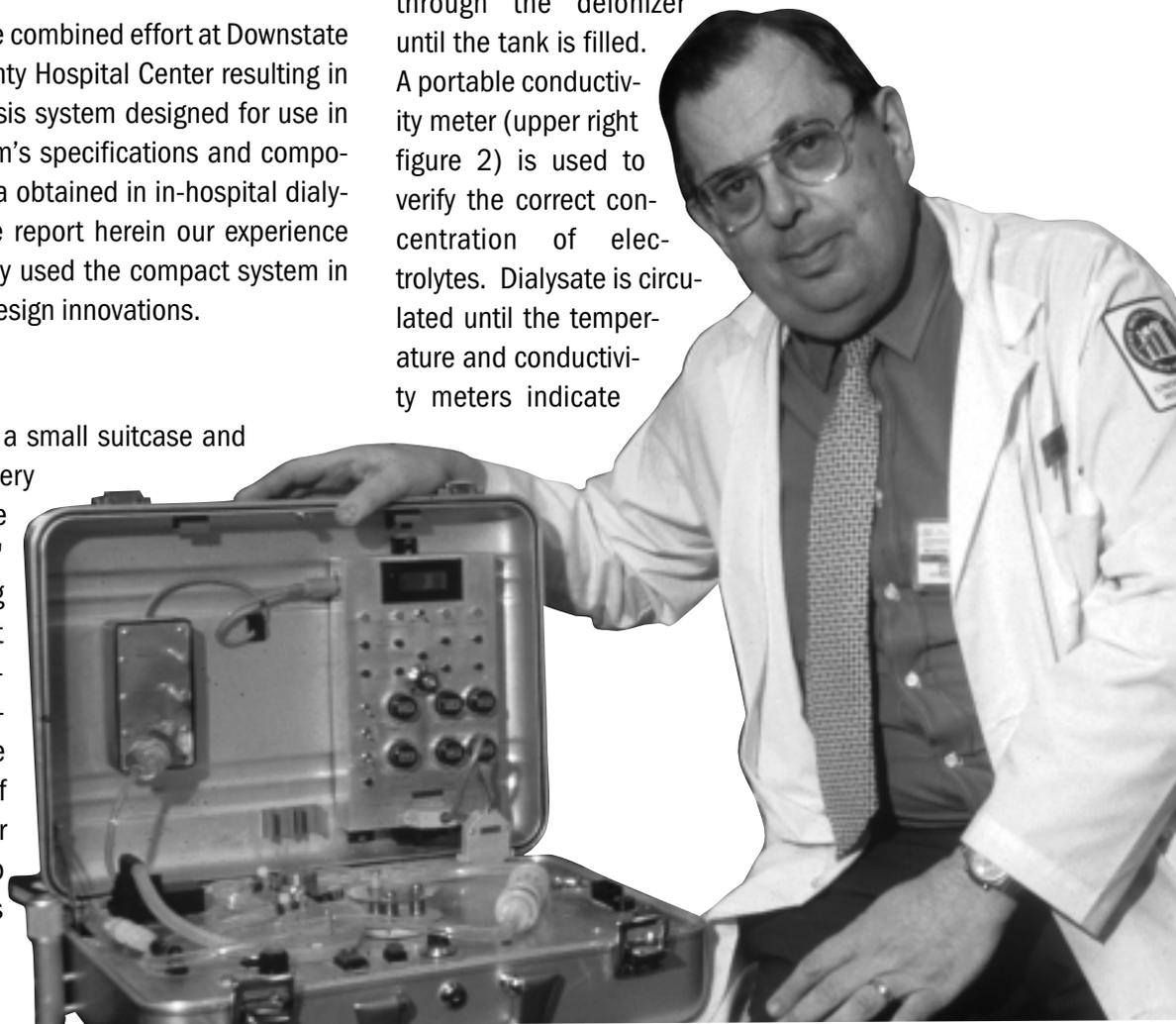
The entire system is carried in a small suitcase and flight bag. The dialysate delivery and monitoring systems are contained in a 21" x 13" x 6" aluminum suitcase weighting 22 pounds (Figure 1). The flight bag is used for carrying accessories, including dialyzers, tubing, collapsible polyurethane dialysate tanks, packets of dialysate powders and deionizer weighing 15 pounds for a trip with 5 scheduled dialyses

(Figure 2). Saline is purchased locally.

Newly fabricated small, high speed blood and dialysate pumps permit the size and weight reduction in the system. Dialysate flow is fixed at 500 ml/min while blood flow can be adjusted from 0-300 ml/in via a variable speed control. Ultrafiltrating rate is determined by an elliptical valve which creates negative pressure in the dialyzer. Drip chamber and negative pressure gauges, as well as indicators of temperature, conductivity and blood leak, are located on the front panel.

The dialysate manifold module incorporates a blood leak detector, conductivity cell, temperature monitoring thermistor and thermocontrol system (Figure 3). All are contained in a 2" x 5" nylon block, which can be removed for cleaning or exchanged when dialysing a hepatitis antigen positive patient.

Preparation of the system for use require addition of the pre-measured dialysate powders (or aliquot of liquid concentrate) to the 21 L dialysate tank. A hose with a multiple fitting adapter is fitted to the hotel sink and warm water is passed through the deionizer until the tank is filled. A portable conductivity meter (upper right figure 2) is used to verify the correct concentration of electrolytes. Dialysate is circulated until the temperature and conductivity meters indicate



normal operating conditions. The blood line, at present, is made by inserting a 6-1/4" length of silastic in place of the usual PVC pump segment of standard tubing. This segment is reusable and is sterilized by soaking in a 0.3% chlorox solution between dialyses. Either a Dow or Cobe hollow fiber dialyzer is fixed to a clamp at the side of the unit and the system is ready for use. An advantage of the Cobe dialyzer is its lighter weight and immediate usability without the need for a saline washout of the packaged fluid. An advantage of the closed recirculating dialysate system employed is the ease of control of ultrafiltration via a calibrated overflow tank which directly measures the quantity of water extracted from the patient.

Initial studies performed on six patients in thirty dialyses have shown that clearances of urea (149 +/- 3.8 ml/min) and creatinine (104 +/- 4.4 ml/min) fall approximately 50% after 90 minutes using a single 21 L bath. For this reason, two bath changes are required during a five hour dialysis utilizing a total of 63 L. Figure 4 shows the serum and dialysate concentrations of urea nitrogen and creatinine, as well as changes in clearance for each solute during a five hour dialysis with bath changes at 120 and 210 minutes. Reduction of serum creatinine was 56% and urea 63% at the completion of dialysis. Thirty-two g of urea and 1.7 grams of creatinine were extracted during the dialysis depicted in Figure 4.

In multiple dialyses for as long as six weeks using this system there was neither clinical nor biochemical significant difference noted in comparison with conventional hollow fiber or coil dialysis systems. Patient acceptance has been uniformly good.

TRAVEL EXPERIENCE

Three patients have used the system while in travel, encompassing 31 days and 12 dialyses. A fourth patient is using the system continuously at home while her own apparatus is undergoing repair. All four are home dialysis patients and have required only three supervised self-dialyses to learn how to operate the compact system. Each patient was provided with sufficient accessories, a detailed check list, including a guide for trouble shooting, and a letter of introduction to a nearby dialysis facility in the vicinity, should problems arise.

The fourth patient has been using the system at home for over two months and twenty-one dialyses. No dialysis has been missed due to mechanical malfunction, nor has there been need for either a physician or technical assistance while in travel. Dialyses were performed at the patient's convenience so as not to interfere with vacation plans.

The most common problem described by the patients was trouble adapting the dialysate tank hose line to hotel faucets which varied widely in size and design. A visit to a local hardware store to obtain a suitable adaptor solved the problem though a more flexible fill nozzle has been developed. It was also found that constant soaking of the silastic pump segment in chlorox caused them to soften and crack after repeated uses. We have since switched to a 0.1% concentration of chlorox. No difficulty was encountered in carrying the system, particularly in airplanes where it neatly fit beneath the seat. Finally, no patient noted any change in well being while in-travel and no deterioration from usual serum creatinine or blood urea nitrogen level has been noted when reassessed on return from travel.

COMMENTS

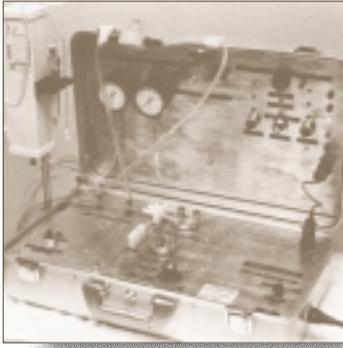
Freedom to travel is a desirable goal in efforts to improve the life style of patients sustained by regular hemodialysis. Availability of a truly portable dialysis system is a substantial step in that direction. Despite some compromise in efficiency due to the small (21 L) dialysate volume, solute removal is adequate over a five hour dialysis provided that two bath changes are performed. The system's simplicity required only brief training periods for patients who have learned home dialysis. A reduction in set-up time should be possible when commercially prepared tubing sets with the silastic pump segment preinserted become available. Increased efficiency of our current model has been obtained by using a larger bore tubing for dialysate recirculation, thus increasing flow to 700 ml/min. Dialysate flow is thus sustained above 500 ml/min even when maximum negative pressure of 300 mmHg is applied.

A substantial advantage of this system is the easy interchangeability of the dialysate manifold which allowed patient 3 who is hepatitis antigen positive, to use the system without contaminating it. On return, the module was removed, cleaned, and reserved for other positive patients. A substitute module was placed in the system, which can then be used for hepatitis antigen negative patients.

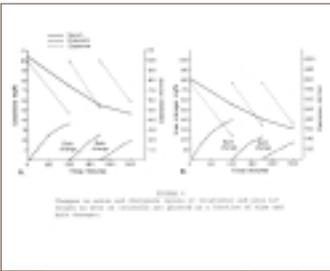
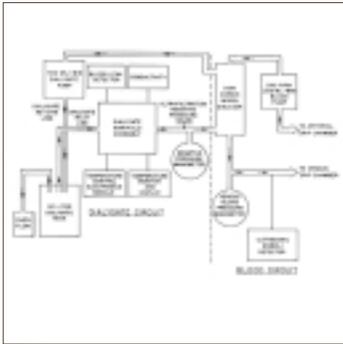
Preliminary experience with patients in-travel has shown that the system is practical and fulfills expectations for flexibility in dialysis schedules essential for maximum enjoyment of a vacation.

BIOGRAPHY

Dr. Eli Friedman is a 1957 graduate of Downstate Medical Center and has been on the faculty since 1963. A Distinguished Teaching Professor of Medicine, Dr. Friedman



was instrumental in creating the Kings County/SUNY Brooklyn Hemodialysis Program in 1964; the nation's first federally funded dialysis unit. Additional support for the overall kidney program was given in the form of an \$85,000 grant from the New York Kidney Foundation. The New York Times dedicated a half page to the grant announcement. Dr. Friedman also instituted a once-unimaginable organization, the Decade Club, made up of people on hemodialysis for ten years and more.



REFERENCES

1. Briefel, GR, Galonsky, RS, Hutchisson, JT, Hessert, RL, and Friedman, EA: *Proceedings of the Clinical Dialysis and Transplant Forum*, 1975.

Figure 1: Latest generation of the portable dialysis system, shown with the Cobe HF130 lightweight dialyzer.

Figure 2: Accessories, including 21 L collapsible dialysate reservoir and packets of premeasured dialysate powders. A Dow hollow fiber dialyzer is shown though other dialyzers may be used.

Figure 3: Schematic diagram of the internal design of the portable dialysis system including the dialysate manifold assembly.

Figure 4: Changes in serum and dialysate levels of creatinine and urea nitrogen as well as clearance are plotted as a function of time and bath changes.

READ MORE ABOUT IT

Friedman, EA, Hutchisson, JT, Galonsky, RS, and Hessert, RL: Devising a practical suitcase hemodialyzer. IN: Chang, TMS (editor): *Artificial Kidney, Artificial Liver, and Artificial Cells*. New York, Plenum Press, 1977. Pp. 33-38.

Friedman, EA, and Lundin, AP: Dialysate delivery. Historical, theoretical, and practical aspect. *Kidney International*, 18, Suppl 10:S33-S43, 1980.

A Celebration of Life. History of the Renal Dialysis Program at Kings County Hospital Center, SUNY Health Science Center, and University Hospital of Brooklyn. SUNY Health Science Center at Brooklyn and Kings County Hospital Center, Brooklyn, NY.