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PD IN DEVELOPING HEALTH CARE SYSTEMS

REPORT OF THE FIRST PERITONEAL DIALYSIS PROGRAM IN GUYANA, SOUTH AMERICA

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♦ ***Introduction:*** **In 2008, we initiated the first Guyanese comprehensive kidney replacement program, comprising hemodialysis (HD), peritoneal dialysis (PD), vascular access procedures, and living-donor kidney transplantation. The government of Guyana, US-based philanthropists, US-based physicians, and Guyanese caregivers teamed up to form a public–private partnership. This pilot program was free of cost to the patients.**

♦ ***Methods:*** **From July 2010 to the time of writing, we placed 17 patients with end-stage kidney disease on PD, which was used as a bridge to living-donor kidney transplantation. During the same period, we placed 12 primary arteriovenous fistulae.**

♦ ***Results:*** **The 17 patients who received a PD catheter had a mean age of 43.6 years and a mean follow-up of 5.3 months. In that group, 2 deaths occurred (from multi-organ failure) within 2 weeks of catheter placement, and 2 patients were switched to HD because of inadequate clearance. Technical issues were noted in 2 patients, and 3 patients developed peritonitis (treated with intravenous antibiotics). An exit-site abscess in 1 patient was drained under local anesthesia. The peritonitis rate was 0.36 episodes per patient–year. Of the 17 patients who received PD, 4 underwent living-donor kidney transplantation.**

♦ ***Conclusions:*** **In Guyana, PD is a safe and cost-effective option; it may be equally suitable for similar developing countries. In Guyana, PD was used as a bridge to living-donor kidney transplantation. We have been able to sustain this program since 2008 by making incremental gains and nurturing the ongoing public–private partnership.**

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KEY WORDS: Developing countries; Guyana; South America; outcomes; infection; kidney transplantation; logistics of peritoneal dialysis; supply of dialysis fluids.

Chronic kidney disease has become a major public health problem—not just in the United States, but worldwide—because the cost of treatment has become a large financial burden for advanced and developing countries alike. Treatment options for end-stage renal disease (ESRD) include kidney transplantation and dialysis. Because the availability of kidney transplantation is limited in developing countries, there is a large and growing need for viable dialysis programs.

We report an initiative to introduce renal replacement therapy, including hemodialysis (HD), peritoneal dialysis (PD), and living-donor kidney transplantation in Guyana.

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BACKGROUND

MEDICAL MISSION

The population of Guyana is estimated to be 751,223 (1). The gross domestic product per capita income is $7,541 (ranking 98 in the world), annual inflation is 12.20%, and the unemployment rate is 11.0% (2). Specialist services are limited, and before 2008, renal failure was considered a death sentence.

Our medical mission started when a Guyanese American in Queens, New York, found a flyer in Queens asking for financial help for a 16-year-old boy dying of kidney failure (3). We formed a public–private partnership with the US doctors volunteering their services as part of an arrangement with the Guyanese Health Ministry to bring relief to the hundreds of Guyanese currently experiencing chronic renal failure. The cost of this initial venture was borne by US-based Guyanese Americans. Later, the Government of Guyana agreed to supply generic immunosuppressive medications, use of operating rooms, hospital stays, and dialysis fluids free of charge. However, HD is not covered by the Guyanese government.

COST OF DIALYSIS TREATMENT IN GUYANA

In Guyana, the cost of HD is US$200 for each session. Comparative costs of HD for one year are US$5,000 in India, $6,240 in Indonesia, $7,500 in China, and $7,332 in Brazil. It seems that the cost of HD is higher in Guyana than in comparative developing countries, making it more imperative to develop a kidney transplantation program. In 2008, there were 3 HD chairs, which have now increased to 10 HD chairs for a population of approximately 1 million, which are all resident in the capital city, Georgetown.

ESTABLISHMENT OF SOCIAL NETWORK

Establishing kidney transplantation required the coming together of 4 communities: Guyanese Americans, the Guyanese Ministry of Health, the US transplantation professionals, and a team of Guyana-based doctors. The American Guyanese business community had undertaken many goodwill health initiatives in their native Guyana in the past. They were therefore familiar with the socioeconomic and political infrastructure of the country. The US medical team, led by the senior author of the present work, had the medical skills to adapt to less-sophisticated medical environments such as the operating facilities that would be encountered in Guyana. The medical team on the ground in Guyana, although lacking the skills needed to perform transplants, was familiar with the social networks and medical history of the patients. The minister of health, Government of Guyana, and his team were ready to facilitate the medical teams and gave an undertaking to provide free medications for at least 3 years (1 year of anti-rejection medication costs about US$8,000). The medical team in Guyana formed a professional network based on a shared opportunity to fulfill a medical need within the country. However, once the US-based team arrived in Guyana, their role became both supportive (by playing host to the visiting team) and assistive (by helping them to negotiate the logistics of hospital life).

INVOLVEMENT OF MULTIPLE MEDICAL INSTITUTIONS IN THE UNITED STATES

Our group are also gearing up to involve other transplant programs in the United States as the program grows. We hope that we will eventually have Guyanese physicians visit transplant programs in the United States to gain first-hand experience of transplantation surgery and medicine.

SKYPE TO CONDUCT LIVE CLINICS

We conducted a number of real-time clinics from the United States during which we talked with patients who received a kidney graft and modified their medications. We also spoke with patients on dialysis who had potential donors. The conferences instilled confidence in the local physicians and the patients.

Here, we report our experience of introducing PD to Guyana, South America. We found that the need for viable options for renal replacement therapy was quite acute in this developing country, in which approximately 10,000 and 8,000 new cases of hypertension and diabetes are diagnosed annually (Guyanese minister of health. Personal communication, 2008). Peritoneal dialysis was introduced as part of a comprehensive kidney replacement program comprising HD, vascular access procedures, and living-donor kidney transplantation. In the future, the government of Guyana intends to create a nationwide registry of patients requiring kidney replacement therapy. Future efforts will also be directed to initiating a deceased-donor kidney transplantation program once the government of Guyana passes a law recognizing the concept of brain death.

The public–private partnership and incremental progress in this endeavor is noteworthy. We started in mid-2008 with a living-donor kidney transplant and progressed to donating HD machines, creating vascular accesses for suitable patients, initiating a PD program, and performing

further living-donor kidney transplants. Performing native kidney biopsies in appropriate patients and having the biopsies interpreted at US medical centers is another step toward establishing a comprehensive program.

METHODS

STARTING A PD PROGRAM IN GUYANA

We initiated the PD program as part of a medical mission that included the first kidney transplant procedure in Guyana. Patients with ESRD could not afford the costs of HD (approximately US$200 per session). From July 2010 to the time of writing, we placed 17 patients on PD. The catheters were placed using the standard open approach. The catheters were graciously donated by various hospitals in the United States. Fluid for PD was supplied free of charge by the Government of Guyana.

TISSUE TYPING

Some tests, such as tissue typing and cross-match, were not done in Guyana. We obtained blood samples to perform the tests in the immunology laboratory at Walter Reed National Military Medical Center, Washington, DC.

RESULTS

The 17 ESRD patients placed on PD (9 women or girls, 8 men or boys) had a mean age of 43.6 years; the youngest was 8 and the oldest was 76 years old. Mean follow-up was 5.3 months (Table 1). The 2 youngest patients (a 15-year-old boy and an 8-year-old girl) died within 2 weeks of catheter placement because of multi-organ failure. Because of inadequate clearance, 2 other patients (a 34-year-old woman and a 76-year-old man) were switched to HD, and catheter malfunction in 1 patient required surgical correction. An exit-site infection that did not respond to antibiotics developed in 1 patient (a 48-year-old woman); once an abscess was surgically incised, she had a functional catheter. The peritonitis rate was 0.36 episodes per patient–year; all infections resolved with intravenous antibiotics.

As part of our medical mission, a living-donor kidney transplant was performed in 4 patients (2 women, 25 and 48 years of age; 2 men, 48 and 38 years of age); their PD catheters were removed surgically at the end of the transplantation procedure. All were doing well at the time of writing. During the same period, we placed 12 primary arteriovenous fistulae (data not shown). Patient preference for HD was the primary reason for placing the fistulae. However, our preference was to initiate patients on PD, because most lived in the coun-

TABLE 1
Patient Demographics and Outcomes

Pt ID	Age	Sex	Cause of kidney failure[a]	Complication	Outcome
EG	34	Female	Hypertension	None	Patient doing well on PD
JA	8	Female	Acute kidney failure	None	Died of multiorgan failure
DD	48	Female	Diabetes, hypertension	Exit-site abscess	Incision and drainage of abscess
GW	48	Male	Hypertension, polycystic kidneys	None	Living graft from daughter
DW	25	Female	Hypertension	Single-episode peritonitis[b]	Living graft from sister
AG	49	Female	Diabetes, hypertension	Catheter blocked	Temporary hemodialysis
AS	51	Male	Diabetes, hypertension	None	Functional
DB	48	Female	Hypertension	None	Died of myocardial infarction
FR	65	Male	Diabetes	Catheter blocked, replaced	Doing well with on PD
KL	44	Male	Hypertension	None	Died at home, reason unknown
TS	15	Male	Acute kidney failure	None	Died of liver failure
KK	43	Female	Hypertension	Single-episode peritonitis[b]	Died at home, reason unknown
GE	34	Female	Diabetes	Inadequate clearance	Switched to hemodialysis
RA	76	Male	Polycystic kidneys	Inadequate clearance	Switched to hemodialysis
ST	68	Male	Obstructive uropathy	None	Doing well on PD
PM	48	Female	Diabetes	Single-episode peritonitis[b]	Living graft from sister-in-law
KS	38	Male	Hypertension	None	Living graft from brother

[a] No patient underwent a native kidney biopsy.
[b] Combination of coagulase-negative and coagulase-positive *Staphylococcus*. The peritonitis rate was 0.36 episodes per patient–year.

tryside and lacked access to the HD facility—and in any case, the cost of HD is prohibitive. A small number of patients who failed PD were offered HD only if they had the financial means and access to a suitable dialysis center (Guyana has very few, and they are located only in Georgetown).

KIDNEY GRAFTS TO DATE

At the time of writing, 12 kidneys had been transplanted, and we expected to perform 8 – 10 living-donor transplantation procedures in 2012.

Based on our experience of PD in Guyana, our recommendations to the local caregivers are these:

- Supply logistics

  The supply of solutions is not reliable and does not necessarily include the usual variety of dextrose concentrations.

  Suggestion: Simplify the fluid selection: use 2.5% in all cases. For more rapid fluid removal, apply an extra exchange (2-hour dwell) for a day or two with fluid restriction, or more liberal fluid and salt intake if less fluid removal required. The hospital could carry a bit more variety and swap, or also carry a single concentration for inpatient use or supplementing outpatients. The full spectrum is desirable, but a single selection is manageable.

- Self-monitoring of PD

  Patients don't consistently have a weigh or spring scale; most seem to have a blood pressure cuff.

  Suggestion: All three pieces of equipment are needed for accurate monitoring of fluid status and ultrafiltration. A floor scale (in kilograms) is needed at least. Weight, together with blood pressure and edema, is very helpful in assessing fluid removal requirements. Without knowing if ultrafiltration is taking place (using a spring scale); only a crude estimate can be made using weight gain, fluid restriction, and edema monitoring. This approach will become less effective if, after longer-term PD, ultrafiltration failure or inadequacy is suspected.

  Further advice: All patients should be counseled to maintain a fluid intake of 1 L per day if weight is at or near target, and edema and blood pressure are controlled. A handout can outline a strategy for fluid restriction and assessment using edema, weight, and blood pressure to determine whether salt and fluid intake should be strict; could be relaxed a little for decreased blood pressure, weight, and edema; or should be decreased; and whether an extra exchange should be used to increase ultrafiltration. A notebook with weight, blood pressure, and ultrafiltration for each exchange should be encouraged for the physician and nurse to review at the monthly visit.

- Dressing practices

  Dressings are optional with healed exit sites. A simple gauze dressing that breathes and is changed daily is preferable. Minimal tape should be used. As part of their self-care regimen, patients should have a supply of 2×2-inch or 4×4-inch dressings, whichever is readily available, and some 1-inch tape. Patient should visually and manually check the transfer set connection each day at the time of their shower.

- Exit-site care practices

  Basically, patients should shower (using liquid soap if possible), wash the catheter and exit site with lather from the liquid soap, rinse, and dry completely. Do not dry with a regular towel, but use a 4×4-inch gauze around the exit site immediately or allow it to air-dry completely. Patients are taught the importance of observing the exit site daily at the time of the daily shower and cleansing of the exit site with soap and water. Signs of infection, a simplified dressing or no dressing, and checking the connectors to assure their snugness are emphasized.

- Storage of PD supplies

  A successful PD program requires familiarity with the necessary supplies and standard protocols. Because PD is still relatively new and unfamiliar to the health system in Guyana, the nomenclature and items are not yet completely familiar, and so positioning the supplies in a specific designated space proximate to the operating room and clinic would be helpful. Similarly, standardizing the type and ensuring the consistent availability of the requisite PD solutions and associated hardware would help to address some of the major shortcoming of this nascent program.

- Type and make of catheter

  We used single-cuff Quinton Curl Cath catheters (Covidien, Mansfield, MA, USA), with a single preperitoneal cuff. We emphasized midline placement with a downward deflection of the tunnel toward the exit site to promote drainage. A single cuff was

chosen for ease of placement and to avoid problems with external cuffs, because our team would return only in several months at the earliest.

- Teaching the patients and training the nurses

  The situation in Guyana was rather unique. Our main PD instructor was a civilian former PD and current transplant patient who worked with the local hospital to train and acquire supplies for the patients. We reviewed the training regimen with him, and we basically emphasized the actual procedure, sterile technique, and complications. We saw the active patients who were able to come to clinic that week, reviewing their current technique, introducing them to fluid restriction and daily weight and blood pressure, and emphasizing the need to keep a notebook with the foregoing data for review at each visit. We had to determine how they could best assess their fluid status with the tools they had available and could afford. As a result, we simplified the regimen as much as possible, using some combination of weight, edema, blood pressure, and pulse to assess the need for fluid restriction or liberalization, or for an extra exchange during the day to aid in fluid removal. Acquiring dialysate was difficult because of the limited availability of the various concentrations (all PD fluid is supplied by the government free of charge), and so we simplified all regimens to 2 L of 2.5% glucose fluid for all 4 daily exchanges. To achieve target fluid weight, we recommended a combination of fluid restriction or liberalization and the possibility of an occasional extra daily exchange if fluid restriction alone wasn't working.

We recommended that specific staff be set aside for PD support. The nursing staff were unskilled with PD, and the HD staff who worked in the intensive care unit were the most likely to have to handle a PD issue. They attended several lectures and practical demonstrations, which were reinforced with Skype teleconferences.

DISCUSSION

We describe the incremental progress of initiating and sustaining a comprehensive kidney replacement program in Guyana. We started by performing the first living-donor kidney transplant and subsequently developed a full dialysis program, with introduction of PD and vascular access procedures. This program will be expanded with the creation of a national registry for ESRD patients, accompanied by a nationwide education program to prevent hypertension and diabetes.

We are gratified that the government of Guyana recognized our efforts and changed the health policy for renal replacement therapy in Guyana. That step was achieved by demonstrating progress and by involving the local press and lobbying the politicians. The government is now committed to supplying anti-rejection medications for life in addition to PD fluid, and it facilitates the use of local hospitals and related facilities for our team from the United States.

INCIDENCE OF KIDNEY FAILURE IN GUYANA

The number of patients requiring renal replacement therapy either by dialysis or kidney transplantation is estimated to be about 1.4 million worldwide, and that number is growing at 8% annually (4). A number of factors may account for the increase; the major factors are diabetes, aging populations, and hypertension. It may be difficult to estimate the burden of renal failure in developing countries because, with some notable exceptions, most lack national registries. However, it is anticipated that the incidence of kidney failure is likely to increase because of a dramatic rise in the incidence of diabetic nephropathy. Developing countries also have a high incidence of infectious causes of kidney disease. The roles of environmental pollution and herbal medicines in causing kidney failure are still being explored.

The population of Guyana is estimated to be 751,223 (1). Data from Singapore, which has a population of a similar size and a national ESRD registry, could be extrapolated to Guyana. In Singapore, the incidence of new ESRD patients treated with dialysis was 96 per million in 1992 and 167 per million in 2000. It would therefore be reasonable to assume that approximately 200 new patients per year would need renal replacement therapy in Guyana. Increases in the incidence of diabetes and hypertension throughout the developing world likely mean that the number of patients requiring renal replacement therapy will increase considerably.

NEED FOR KIDNEY DONATION IN GUYANA

In India, fewer than 10% of all patients receive any kind of renal replacement therapy. Most patients are on HD, with only a small proportion (<0.5%) initiating on PD. About 60% are lost to follow-up within 3 months, primarily for economic reasons. Further, although renal transplantation is a cheaper option in India because of lower maintenance costs over time, only about 5% – 10% of patients with kidney failure receive a graft (5). From various newspaper reports of people looking for help to travel abroad for kidney transplantation, it would seem

that a similar situation currently exists in Guyana, where probably only 10% of patients receive any type of renal replacement therapy and only 5% – 10% of them receive a kidney graft.

BURDEN OF ESRD IN GUYANA

In the absence of nationwide reporting systems or registries, the true incidence and prevalence of ESRD is difficult to determine. Modi and Jha (6) reported from an urban population in the city of Bhopal, India, that the crude and age-adjusted ESRD incidence rates were 151 and 232 per million population respectively. A similar situation may exist in Guyana.

In initiating an effective and worthwhile dialysis treatment program in a developing country, one of the primary issues is the matter of cost. The simple fact is that many developing countries do not have the resources to set up a health care program with the level of service seen in programs that exist in the West. In addition, kidney failure tends to affect a relatively small percentage of any nation's population, and so it is understandable that developing countries with very limited resources are financially unable to provide long-term renal replacement therapy to patients when they have other more pressing priorities such as infectious diseases (7).

In constructing a dialysis unit in a developing country, the initial question that must be asked is whether to rely primarily on PD or HD. Although many developed nations, such as the United States, rely heavily on the use of HD, evidence points in favor of using PD in developing countries, because the PD technique is more cost-effective and has a lesser reliance on modern technology (8). The overall cost of using PD instead of HD can be seen when analyzing the typical costs associated with dialysis machines, solutions, maintenance, and utilities between the two systems. To set up a HD program, a country must purchase multiple machines that typically cost from UD$18,000 to US$30,000 and have only a 5- to 10-year lifespan. In addition to the machines, dialyzers for HD must be obtained at a cost that can range from US$1,000 – US$5,000 annually. Additionally, hidden costs such as maintenance and utilities for the machines must be taken into account. On the other hand, expenditures for PD depend on the price of solutions and dialysis tubing, which can range from US$5,000 to US$25,000 annually and which are added to the cost for automated cyclers, which can range between $US3,000 and US$10,000 each. However, cyclers can often be leased for long-term use or may not be necessary for every patient, which can provide significant cost savings (9).

Given that the use of both PD and HD has become widespread in developed countries, it has been shown that the use of PD can result in significant cost savings both to health care providers and to governments looking for a less expensive, and yet effective, method of dialysis. Neil *et al.* (10) found that increasing the use of PD in the United States from its current rate of 8% to 15% would potentially produce savings of more than US$1.1 billion to the health care system over 5 years.

The use of PD has been reported to be cost-effective in several developing countries. Those countries include India [savings of US$40 per patient month with PD (11,12)], Mexico [savings of approximately US$9,000 annually per patient with PD (13)], Malaysia and Hong Kong (savings of US$205 and US$1,500 per patient–month respectively with PD (14)], and Turkey (savings of US$400 annually per patient with PD (15)]. Other countries, such as Sri Lanka, have also shown a similar decline in costs when using PD rather than HD; however, adequate availability of dialysis fluids is important. Neil *et al.* (16) also analyzed the estimated cost savings for various countries in various income brackets (high-income, middle-income, and lower-income) if they were to switch from a HD-dominant system to PD and found that PD was a clinically effective option that can result in significant cost savings.

Although the cost-effectiveness of a dialysis program is important for a developing country, providing patients with the best available option that has also been proved to be an effective treatment is essential. Overall, several studies have shown that outcomes with the use of HD and PD are not significantly different, and available data show that, overall, outcomes in patients with ESRD are comparable between those two dialysis modalities (17,18). A Canadian research team analyzed survival trends among 11,970 patients with ESRD and found that, compared with the patients receiving HD, those receiving PD had a significantly lower mortality rate after adjustments for known prognostic factors (19). Recent research in countries such as the United States (1,20), the United Kingdom (21), Canada (22), Taiwan (23), and Germany (24) has shown that, in terms of survival, PD has a beneficial impact that is similar to the impact with HD. Similar favorable outcomes with PD have been reported in several developing countries.

The use of PD was also previously shown to be effective in developing countries such as India, where researchers used PD treatment in remote regions and evaluated its effectiveness. Vikrant *et al.* (25) showed that, in 541.1 patient–months of PD use, they were able to treat patients without serious complications such as exit-site infections or peritonitis. Rubin *et al.* (26) not

only showed that patient outcomes with PD were equal to those with HD, but also that patients receiving long-term dialysis clearly preferred PD. When asked to rate their satisfaction with their dialysis, 85% of PD patients rated their dialysis care as "excellent"; just 56% of HD patients gave their dialysis that rating.

In India, the cost of one 2-L bag of fluid is Rs170 (US$1 = about Rs50), and the total monthly cost of bags, assuming 4 exchanges daily, 7 days per week is about Rs21,000 (27). Assuming thrice-weekly HD sessions and a new kit every 2 weeks, the total minimum monthly cost is Rs17,000. However, the capital expenditure for the purchase of HD machines and a reverse osmosis water treatment plant is enormous. The Government of Guyana currently purchases their supplies from India and provides them free of cost to the patients. However, long-term HD is not provided for free; the cost is approximately US$200 per session.

Considering both cost-effectiveness and patient outcomes, the use of PD in developing countries appears to be the best overall option when trying to establish a viable and functional dialysis unit. However, we feel that HD facilities are also valuable and should ideally be available for acute dialysis and for backup in the case of PD complications. Whenever possible, kidney transplant programs should be developed in tandem with dialysis programs, because transplantation clearly provides the best patient survival and better quality of life (28).

CONCLUSIONS

We initiated the first PD program in Guyana, South America, as part of a medical mission. Despite formidable logistics and training issues, 17 patients underwent placement of a PD catheter and 4 patients were successfully transplanted with living-donor kidneys. Our program is sustained through the ongoing and enthusiastic commitment of the government of Guyana, US-based philanthropists, US-based physicians and nurses, and Guyanese caregivers.

DISCLAIMER

The views expressed in this paper are those of the authors and do not reflect the official policy of the Department of Army, the Department of Defense, or the United States Government.

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DISCLOSURES

The authors have no financial conflicts of interest to declare.

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