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EXPANDING CAPD IN LOW-RESOURCE SETTINGS: A DISTANCE LEARNING APPROACH

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Abstract

Background—Despite growing need, treatment for end-stage renal disease is limited in low- and middle-income countries due to resource restraints. We describe the development of an educational curriculum and quality improvement program to support continuous ambulatory peritoneal dialysis (CAPD) performed primarily by non-nephrology providers in Sri Lanka.

Methods—We developed a program of education, outcome tracking, and expert consultation to support providers in Kandy, Sri Lanka. Education included videos and in-person didactics covering core topics in CAPD. Event-tracking sheets recorded root causes and management of infections and hospitalizations. Conferences reviewed clinical cases and overall clinic management. We evaluated the patient census, peritonitis rates, and root causes and management of infections over 1 year.

Results—The curriculum was published through the International Society of Nephrology online academy. High provider turnover limited curriculum assessments. The CAPD patient census rose from 63 to 116 during the year. The peritonitis rate declined significantly, from 0.8 episodes per patient-year in the first 6 months to 0.3 in the latter 6 months, though the most common root causes of peritonitis, related to contamination events and hygiene, persisted. The appropriate ascertainment of culture data and prescription of antibiotics also increased.

Conclusions—Our project supported the expansion of a CAPD program in a resource-limited setting, while also improving peritonitis outcomes. Ongoing challenges include ensuring a durable

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DISCLOSURES

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educational system for rotating providers, tracking outcomes beyond peritonitis, and formalizing management protocols. Our program can serve as an example of how established dialysis programs can support the burgeoning work of providers in resource-limited setting.

Keywords

Peritoneal dialysis; continuous ambulatory peritoneal dialysis; chronic kidney disease of unknown origin; quality improvement; peritonitis; low- and middle-income countries

Many patients who develop end-stage renal disease (ESRD) in low- and lower-middle-income countries (LMIC, gross national income per capita of \$1,005 or less, or between \$1,006 and \$3,955, respectively) either have no access to life-prolonging dialysis or cannot afford the required copayments (1–4). This is especially true in the most economically disadvantaged and rural areas of the world, including most areas of Asia and Africa (3). One of these regions, Sri Lanka, is currently faced with an epidemic of unknown chronic kidney disease (CKDu), with over 20,000 deaths in the last decade and significant socioeconomic distress as a result (5–7).

Sri Lanka is a lower middle-income country with more than 20 million citizens and a gross national income of \$3,780 per capita in 2016 (4,7). The country provides free government-funded healthcare through the Ministry of Health. This care is distributed via a tiered network of urban teaching hospitals paired with smaller rural district hospitals and peripheral clinics. Unfortunately, adequate access to care is not universal, especially for costly and complicated treatments like renal replacement therapy (RRT).

Currently, with financial support secured from the government, nephrologists at Kandy Teaching hospital in Sri Lanka are developing a continuous ambulatory peritoneal dialysis (CAPD) program. While hemodialysis facilities are expanding in parallel, local nephrologists are emphasizing CAPD for several reasons, including to better facilitate dialysis for those living in remote areas, to reduce the time burden of dialysis, to allow greater freedom to work, and to reduce the cost of RRT and thus bring dialysis to more patients overall. The nascent CAPD program faced several challenges, however, including low patient uptake, high rates of peritonitis, and high staff turnover (6).

To improve outcomes from this program, and with an eye towards building resources to promote the use of CAPD in other low-resource settings, we developed an online and in-person hybrid PD educational and quality improvement program. This program is aided by a Sister Renal Center grant through the International Society of Nephrology (ISN), that connects local providers with nephrologists at Stanford University (8). We now report the key components of this program, which could serve as a model for replication in similar settings, and results after 1 year of implementation.

METHODS

We followed a traditional developmental structure for quality improvement projects as outlined in the United States Health Resources and Services Administration national guidelines (9). The core elements of the quality improvement and education plan, as adapted

to the current intervention, are shown in Table 1. The study was approved by the Kandy Hospital Ethical Review Committee. After an initial needs assessment, we designed 3 main components: didactic educational training, outcome tracking capabilities, and communication and feedback channels.

DIDACTIC EDUCATION TRAINING

We developed slide-based video modules through Microsoft PowerPoint with voiceover recording and editing via Camtasia (10). The final modules were approximately 10 – 20 minutes long and intended for a non-nephrology healthcare provider audience. Notably, non-nephrology trained personnel provide a substantial portion of CAPD care in this program as well as in many programs globally. The didactic topics are outlined in Table 2. Educational content, as well as the quality improvement materials described below, was developed and validated using previously established curricula, review materials, and International Society for Peritoneal Dialysis (ISPD) guidelines (11–17).

Based on the content in the video modules, we created an overall pre- and post-curriculum knowledge assessment using multiple choice and short-answer questions. We also created shorter post-module evaluations to track comprehension and progress.

TRACKING OUTCOMES

Following an initial needs assessment with local providers, we used core PD quality metrics to develop event-tracking sheets that enabled the structured recording and assessment of the following clinical events: peritonitis (culture-negative and culture-positive), exit-site and tunnel infections, and hospitalizations. These sheets are available upon request and through the International Society of Nephrology (ISN) Academy.

COMMUNICATION CHANNELS

We held clinical case conferences via video and phone conferencing every 2 months. Local medical trainees presented individual cases for discussion with Stanford dialysis providers. We reviewed active clinical cases (e.g. patients with infections, vascular disease in ESRD, and hypervolemia) as well as how clinic management, data collection, and quality improvement was progressing over the year.

STATISTICAL ANALYSIS

We calculated peritonitis rates as episodes per patient per year. Rates of peritonitis and event sheet completion, as well as markers of PD care (e.g. culture positivity, appropriate antibiotic duration, and patient retraining), were compared between the 6-month period preceding, and the 6-month period after, completion of the in-person educational modules. *P* values were generated via categorical data comparisons with Fisher's exact tests. We also compared assessments of root causes and management for peritonitis, exit-site infections, tunnel infections, and hospitalizations between these periods.

RESULTS

LEARNER ENGAGEMENT AND ASSESSMENT

In conjunction with the ISN, the video modules and assessments are now available as an e-learning curriculum through the ISN Academy (18). This curriculum is available free of charge to learners from LMICs. It is designed to be utilized in its entirety to provide a foundational knowledge base for providers with limited or no nephrology experience.

Within our program, 11 learners completed the pre-curriculum assessment with a median correct score of 52%. The video modules were completed 21 times by 11 learners while 4 learners completed 3 or more of the 6 modules provided. Completion of the online post-video module assessments was limited by internet access capabilities as well as the ongoing turnover of learners within the 12-month period. Due to this high staff turnover, a post-curriculum assessment was not completed. Twenty-five learners completed the in-person educational sessions. They consisted of nephrologists, general medical officers, surgical officers, nursing officers, and healthcare assistants.

PATIENT DEMOGRAPHICS, CENSUS, DIALYSIS SETUP

The patient census rose steadily during our first year of the program from 63 patients in July 2016 to 116 patients by June 2017 (Figure 1). Sixty percent of the patients were male, with an average age of 52 years (range 19 – 74), and the majority of patients were of Sinhala background (Table 3). The 2 most common causes of ESRD were CKDu and diabetes. Overall, the numbers of patient deaths and technique failures through the year were low, 11 and 7 respectively.

Continuous ambulatory PD exchanges were performed using Baxter systems and the program uses Covidien/Medtronic Argyle Swan Neck Curl Cath 2 cuff 62.5 cm catheters. Peritoneal dialysis solutions used were dextrose-based solutions (Dianeal PD-2; Baxter Healthcare, Deerfield, IL, USA) with a standard starting prescription of 1.5% dextrose exchanged approximately every 8 hours.

PERITONITIS RATES, CAUSES, MANAGEMENT, AND HOSPITALIZATIONS

The peritonitis rate decreased from 0.80 episodes per patient-year in the first 6 months of the project (during which time our initial site visit and in-person didactic trainings were completed), to 0.38 per patient-year in the latter 6 months. Applied to a sample population of 100 patients, this would be a reduction from 80 cases of peritonitis a year to 38 (*p* value for comparison < 0.01, Table 4). The monthly number of peritonitis cases is shown in Figure 1 in relation to the patient census and timeline of our site visits and in-person didactics.

The peritonitis event sheets captured details on the presentation, diagnostics, root causes, and management of peritonitis, but were incompletely used (Table 4). However, based on the limited available data, we noted evidence for moderate improvement in culture-positive peritonitis and appropriate antibiotic duration in the 6 months after completion of the didactic sessions, during which we discussed techniques for inoculating peritoneal fluid into blood culture bottles (BD BACTEC Plus Aerobic medium) in the treating clinic (Table 4).

Importantly, rates of culture-negative peritonitis still remained significantly above recommended goals.

The root causes of peritonitis were similar throughout the year and consisted primarily of known contamination events or improper connections during an exchange, poor hand hygiene, and a lack of masking during exchanges. We recorded 17 hospitalizations. The primary causes of hospitalization included hypervolemia, peritonitis, non-peritoneal infections, catheter dysfunction, and cardiovascular disease.

DISCUSSION

In our multi-component quality improvement project, we identified several successful strategies for expanding CAPD in busy, low-resource clinics. We also identified several challenges. Successful strategies included educational interventions such as recurring clinical case conferences, in-person didactics, and outcome tracking initiatives. With these initial steps, the Kandy CAPD program has built a solid foundation for future growth. Initially, patient enrollment was low and peritonitis rates were high. Both challenges are beginning to show steady improvement.

Peritonitis rates decreased throughout the year, likely due to multiple reasons including a heightened emphasis on standardized patient care with improved event recording and the educational training provided to both staff and patients. The clinic space now includes more visual cues for patient training and management of peritonitis. Providers hospitalized a greater proportion of patients for inpatient treatment of peritonitis at Kandy Hospital. Measures to reduce culture-negative peritonitis rates, such as inoculating culture media at the treating clinic, likely improved treatment success. The expansion of the program with the inclusion of lower-risk patients, the increasing experience of providers, as well as the potential exclusion of higher-risk patients through the low, but present, rates of death and technique failure, also likely contributed to the observed improvement in peritonitis rates.

The most challenging aspect of this project was creating an environment of sustainable educational training in the face of high staff turnover. Many learners did not complete the entire curriculum prior to transferring to their new jobs. In addition, limited internet access restricted learner engagement, especially for nurses and healthcare workers who have significant demands in the clinical setting. Moving forward, the CAPD program has set new goals to address this challenge. Nurses' duties have been limited to their respective hemodialysis and PD units. Local providers will implement bi-monthly medical officer-led educational conferences based on the online modules. This will allow all learners to review the content in a structured setting, with medical officers communicating directly with nursing officers and health aids who may struggle with medical comprehension. In addition, the creation of a formalized patient training and management manual based on ISPD guidelines is expected to further improve care (11,14–17).

We also experienced challenges with the incomplete tracking of hospitalizations and infections. This incomplete tracking may have reduced our ability to clearly demonstrate improvement in peritonitis management. We expect improvement in the use of tracking

sheets with the following changes: 1) structuring clinical outcome tracking within the routine clinic work-flow, 2) implementing quality assurance and quality improvement meetings, and 3) addressing communication gaps between nurses and healthcare aides through monthly clinic meetings. Ongoing improvements in clinic data tracking will enable identification of other gaps in care.

Moving forward, the expansion of dialysis globally in the context of constrained budgets across heterogeneous health systems has many challenges. The government of Sri Lanka, similar to governments in China, India, Thailand, and the Philippines, has begun expanding coverage for its patients in need (19–23). Focusing on CAPD in this process offers several potential advantages over hemodialysis for low-resource countries striving to provide high-quality care that maximizes utility gains and justly distributes resources (24). These include the potential for lower costs, reduced technological and provider requirements, and the ability to preserve a patient's independence and ability to work (3). Unfortunately, published reports of dialysis costs in LMICs are highly variable in methodology and therefore estimates of cost, and those specific to Sri Lanka have not formally assessed PD as it is currently delivered (25,26). In general in LMICs, PD equipment and solution costs can sometimes push the costs of PD beyond that of hemodialysis. At Kandy Teaching hospital, a reliable supply chain from Baxter in India has been established, which results in lower annual costs of CAPD per patient, compared with hemodialysis (27). Furthermore, wage-earning patients highly value the ability to work with fewer time constraints while on PD.

CONCLUSIONS

Education, quality improvement, and an ongoing working partnership between a nascent and established PD program were key elements in supporting CAPD use in our experience. With these goals in mind, we aim to strengthen our educational and quality improvement program and pursue wider implementation. Clearly, as the global community embraces the thoughtful expansion of RRT in low-resource settings, practical modes for the implementation of high-quality CAPD programs will be crucial.

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Figure 1. Patient census (bar graph, prevalent PD patients per month) and peritonitis episodes (line graph, number of peritonitis cases each month). PD = peritoneal dialysis.

TABLE 1**Core Elements of the Quality Improvement and Education Plan**

QI element	Implemented component
Systematic approach	<ul style="list-style-type: none"> Identified leadership and structure through Stanford University, Sri Lankan Ministry of Health, and ISN Sister Renal Center program Guaranteed funding for PD care
Measurable program objectives	<ul style="list-style-type: none"> Knowledge acquisition in learners Program census Rates of peritonitis Rates of exit-site and tunnel infections Rates of hospitalization Rates of PD technique survival
Systematic data collection	<ul style="list-style-type: none"> Learner assessment Census tracking sheets Event reports detailing clinical data and root cause evaluations for core clinical outcomes <ul style="list-style-type: none"> – Peritonitis – Exit-site and tunnel infections – Hospitalization
Teaching intervention	<ul style="list-style-type: none"> Video-based modular peritoneal dialysis curriculum In person small-group didactics Clinic site-visits and case review Clinical case conference – every 2 months
Measurable assessment of individual learners	<ul style="list-style-type: none"> Pre- and post-curriculum knowledge assessments Post-module knowledge assessments
Feedback	<ul style="list-style-type: none"> Clinical case conference – every 2 months Review of census and peritonitis sheets

QI = quality improvement; ISN = International Society of Nephrology; PD = peritoneal dialysis.

TABLE 2

Educational Topics for Video Modules and In-Person Didactics

Video modules	In-person didactics
• Introduction to ESRD and PD	• Overview of PD physiology
• Introduction to PD Catheters	• Catheter placement and care
• PD catheter complications	• Management of catheter complications
• Solute transport	• Fluid volume management in PD
• PD regimens	• Peritonitis: diagnosis, management, and reducing culture-negative peritonitis rate
• Volume management in PD	• Non-infectious complications of PD
• Infection prevention in PD	• Educating patients about CKD, ESRD, and renal replacement therapy
• Infection diagnosis and management in PD	• Infrastructure of a CAPD program
• Non-infectious complications of PD	• PD patient home visits
• Teaching PD to patients	• Case conference workshops

ESRD = end-stage renal disease; PD = peritoneal dialysis; CKD = chronic kidney disease.

TABLE 3**Representative Patient Demographics^a**

Demographic	
Age (yrs)	52±14
M/F (%)	62/38
Ethnic background (%)	
Sinhala	74
Muslim	15
Tamil	6
Unknown	6
Occupation (%)	
Farmer	12
Business	9
Government	9
Police/security	9
Student	3
Unknown	58

^aBased on incident patients from Kandy Teaching Hospital and Girandurukotte Hospital (a peripheral clinic) during the second 6 months of the study.

TABLE 4

Peritonitis Rates, Event Sheet Capture, and Management of Peritonitis

	July–Dec 2016 (%)	Jan–Jun 2017 (%)	<i>P</i> value
Cases of peritonitis/peritonitis rate (episodes per patient year)	31/0.8	16/0.38	0.0001 ^a
Peritonitis event sheet completed	21 (68)	8 (50)	0.34 ^b
Culture-positive	6 (29)	4 (50)	0.39 ^c
Appropriate antibiotic duration (14+ days)	5 (24)	4 (50)	0.21 ^c
Retraining after peritonitis episode	18 (86)	7 (88)	1.00 ^c

^a*P* value comparing 6-month peritonitis rate.

^b*P* value comparing percentage of event sheets completed.

^c*P* value comparing data based on event sheets that were completed.

Note: percentage rates for culture positivity, antibiotic duration, and retraining rely on completed peritonitis event sheets.