

Peritoneal Dialysis in Asia

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Key Words

Asia · End-stage renal disease · Peritoneal dialysis · Prevalence · Renal registry

Abstract

Background: There is a growing demand of dialysis in Asia for end-stage renal failure patients. Diabetes mellitus is the leading cause of end-stage renal failure in many countries in Asia. **Summary:** The growth of peritoneal dialysis (PD) in Asia is significant and seeing a good trend. With the enhanced practices of PD, the quality of care in PD in Asia is also improved. Overall, PD and hemodialysis (HD) are comparable in clinical outcome. There is a global trend in the reduction of peritonitis rates and Asian countries also witness such improvement. The socio-economic benefits of PD for end-stage renal failure patients in both urban and rural areas in the developed and developing regions of Asia are an important consideration. This can help to reduce the financial burden of renal failure in addressing the growing demand of patients on dialysis. Initiatives should be considered to further drive down the cost of PD in Asia. **Key Messages:** Growing demand for dialysis by an increasing number of end-stage renal failure patients requires the use of a cost-effective quality dialysis modality. PD is found to be comparable to HD in outcome and quality. In most countries in Asia, PD should be more cost-effective than HD. A 'PD-first' or a 'PD as first considered therapy' policy can be an overall strategy in many countries in Asia in managing renal failure patients,

taking the examples of Hong Kong and Thailand. **Facts from East and West:** (1) PD is cheaper than HD and provides a better quality of life worldwide, but its prevalence is significantly lower than that of HD in all countries, with the exception of Hong Kong. Allowing reimbursement of PD but not HD has permitted to increase the use of PD over HD in many Asian countries like Hong Kong, Vietnam, Taiwan, Thailand, as well as in New Zealand and Australia over the last years. In the Western world, however, HD is still promoted, and the proportion of patients treated with PD decreases. Japan remains an exception in Asia where PD penetration is very low. Lack of adequate education of practitioners and information of patients might as well be reasons for the low penetration of PD in both the East and West. (2) Patient survival of PD varies between and within countries but is globally similar to HD. (3) Peritonitis remains the main cause of morbidity in PD patients. South Asian countries face specific issues such as high tuberculosis and mycobacterial infections, which are rare in developed Asian and Western countries. The infection rate is affected by climatic and socio-economic factors and is higher in hot, humid and rural areas. (4) Nevertheless, the promotion of a PD-first policy might be beneficial particularly for remote populations in emerging countries where the end-stage renal disease rate is increasing dramatically.

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For peritoneal dialysis in Western countries, see Struijk, *Kidney Dis* 2015;1:157–164.

Introduction

Asia is the largest and most densely populated continent on Earth, encompassing more than 30 countries across the northern and eastern hemispheres. It approximately comprises 30% of Earth's land area and is the home of roughly 60% of all the human population [1]. With a world population of 6.915 billion, Asia constitutes 4.165 billion [1]. However, much diversity exists in the ethnic groups, cultures, environments, economics and government systems. Therefore, much diversity exists between different Asian countries in terms of disease distribution, choice of therapies and healthcare-related outcomes.

Asia encompasses a large number of low-income and developing countries. Their healthcare systems may not be well developed, and few have comprehensive renal registries. However, the prevalence of end-stage renal disease (ESRD) is increasing worldwide and some Asian countries were noted to have a significant and rapid rise of both incidence and prevalence of ESRD cases every year. In 2012, Taiwan, Singapore, Japan, Malaysia, Thailand and Korea ranked 2nd, 4th, 5th, 8th, 9th and 10th in the incidence rate of ESRD, while Taiwan, Japan, Singapore, Korea and Hong Kong ranked 1st, 2nd, 4th, 7th and 11th in the prevalence of ESRD. Among patients suffering from ESRD, the highest incidence rate has been noted in those aged 65 years or older. Hence, ESRD poses a significant financial burden on these countries as well as significant stress on the medical system [2].

Within all ESRD patients in these countries, diabetes mellitus (DM) topped the most common cause from around 40–50% in Hong Kong, Taiwan, Japan and the Philippines to as high as 66% of ESRD patients in Singapore. Hypertension is another common cause of renal failure in these countries. When compared to other Western countries, there is a higher percentage of ESRD patients suffering from glomerulonephritis; this may be caused by a generally more crowded environment as well as more infectious diseases [2].

Renal replacement therapy (RRT) is a standard choice of treatment in patients suffering from ESRD in the Western world, and obviously it can alleviate symptoms related to ESRD as well as prolong survival. In general, RRTs in Asia are expensive as they rely on imported technologies mainly from the Western world. Private healthcare dominates in the RRT provision in developing countries and there may be little or no financial support from the government. Sadly, an estimated >90% of patients in South Asia die within months of ESRD diagnosis because

of lack of financial support for RRT. The overall provision and choice of RRT varies among different countries [1, 3].

Peritoneal Dialysis Prevalence and Utilization Rates

In-center hemodialysis (HD) remained the most common form of dialysis therapy in the world, as well as in Asia, followed by peritoneal dialysis (PD) and home HD. However, PD is still having a higher prevalence in Asia, where there are more developing countries than in the Western world. In 2013, the total PD population around the world was estimated to be 272,000 while that of HD was estimated to be 2.25 million [4]. An analysis of the distribution of the PD population worldwide demonstrates that 65% of patients who receive PD live in developing countries, whereas only 40% of patients who receive HD live in these countries. In the same report, the Asia Pacific region topped with a 23% prevalence of PD patients in the world [4, 5].

The overall low utilization of PD is multifactorial. However, non-medical factors, such as issues associated with healthcare organizations and reimbursement, are the most important factors that influence PD use in Asia as well as globally, as these factors directly affect the availability of different types of dialysis modalities in a particular region. Among all Asian countries with a renal registry, Hong Kong is the only one having more patients on PD than HD, with 73% of all RRT patients receiving PD, mainly due to its PD-first policy. Under this policy, continuous ambulatory PD (CAPD) is provided as the first-line dialysis modality unless it is contraindicated medically [6, 7]. All ESRD patients in Hong Kong are informed and free to choose either PD or HD on initiation of dialysis, but only PD expenses will be reimbursed if the patient has no medical contraindication to PD [7]. New Zealand and Australia are among the most prevalent countries with PD patients comprising 31.0 and 19.5% of the whole RRT population, respectively. These two countries' dialysis delivery is dominated by public providers and PD is supported by the government as it is perceived to be the cheaper option compared to other modalities. This contributes to a high prevalence of home dialysis modalities, including PD, among ESRD patients [8].

It has been observed that in some Asian countries, including those places where PD is prevalent as mentioned above, there is some decrease in the percentage of patients on PD. For example, from 2006 to 2012, the percentage of PD patients decreased from 81.0 to 72.9% in Hong

Kong, from 38.3 to 31.3% in New Zealand and from 22.0 to 19.5% in Australia. Possible causes include the need for expansion of HD capacity to cope with those patients who failed on PD. Also, the promotion of the use of home HD as an additional home therapy is another reason in Hong Kong, Australia and New Zealand. However, it has been postulated that while there is a decline in the proportion of PD patients mainly in those developed countries, there was actually an increase in the absolute number of patients treated with PD worldwide from 1997 to 2008, with a 2.5-fold increase in the prevalence of PD patients in developing countries [5]. The annual global growth rate of PD is estimated to increase by 8% compared with 6–7% for HD [4].

Japan, when compared with other developed Asian countries, has had a very low PD penetration rate all along, with a mere 3.4% by the end of 2009. Explanations for why the PD rate remained low included lack of information and education among both patients and nephrologists and an overwhelming fear of developing encapsulating peritoneal sclerosis [9]. However, with recent new multidisciplinary approaches to tackle this problem of encapsulating peritoneal sclerosis in Japan and more interest from Japanese nephrologists in putting patients on PD, it is likely that the trend of PD penetration in Japan will increase [10].

The actual burden of ESRD, the provision of PD and its associated problems remain largely unknown in many developing Asian countries with a lack of access to healthcare, organized care for renal diseases as well as comprehensive renal disease registries. An overview of PD therapy in some Asian countries can be obtained from individual studies and reports.

For example in India, one of the most populous countries in Asia, it was estimated that the crude and age-adjusted incidence rates of ESRD are around 151 and 229 per million population, respectively, and that DM is the most common cause of ESRD. Compared with the developed world, the mean age of patients requiring RRT in India is lower, comprising individuals in the most productive years of their lives, often the sole wage earners of families with multiple dependents. Since its introduction in 1991, CAPD has become an established form of therapy in adults with ESRD in India. CAPD is gradually increasing among ESRD patients: it was 5% in 1996, 10% in 1998, 14% in 2002, and approximately 21% in 2008 [10]. It was observed that the growth of PD became more prominent in 1994 when the PD fluid was manufactured locally [3]. It was estimated that the cost for PD and HD are comparable in India, but still PD is seldom offered as

a first-choice dialysis therapy, and only patients with multiple comorbidities not suitable for HD are initiated on PD. Several proposed reasons include unfounded fears of infection due to the hot, humid climate and poor hygienic conditions, but the infection rates in most Indian PD programs are acceptable by international standards. Delayed presentation to dialysis units is another possible cause as it gives insufficient time for patient education and the preparation required for PD. Also, nephrologists who have their own HD units have a bias against PD for financial reasons. As a result, PD suffers from high drop-out rates, most within the first few months after initiation [11].

In general, the overall provision of RRT to ESRD patients in India is severely limited by financial reasons. It was estimated that over 60% of stage 5 chronic kidney disease patients were being managed with conservative treatment without dialysis at the time of presentation. Previous studies have shown that a large proportion of these cases require emergency dialysis soon after presentation, but are unable to continue on a long-term basis because of financial reasons. The problems regarding renal care in India and Pakistan reviewed by Jha [12] include the concentration of the majority of nephrology-related services in expensive private sector hospitals with severe limitation in the availability of RRT to large sections of the population, as well as expensive HD and PD services in relation to the citizens' income and suboptimal dialysis prescriptions. Renal transplantation is the most suitable option for a majority of patients, but is dependent on living donors. Realizing this problem, the Indian government is currently considering providing dialysis to the entire population through a network of standalone centers through partnership with private healthcare providers. However, this is limited by a shortage of trained dialysis physicians, technicians and nurses [13].

There has been a general blooming of the economy in most Asian countries since the 1990s, and this allows more medical resources to be available to the general population, including dialysis services. In China for example, the number of chronic kidney disease patients is estimated to be approximately 119.5 million [14–16]. Glomerular disease, especially IgA nephropathy which contributed up to 45.3% of all primary glomerulonephritis, was the most common cause of ESRD, followed by diabetic nephropathy and hypertension [14]. A survey by the Chinese Society of Blood Purification estimated that the point prevalence of patients with ESRD on maintenance dialysis was 71.9 per million population in 2008, with an annual increase in the prevalence of 52.9% [15]. This puts

a large economic burden on individuals and on health-care resources. Under the new Chinese health reform strategy, the Chinese government aims to expand health insurance to cover more chronic and major diseases identified as a priority and to reduce the financial burden for individual patients. Local civil affairs bureaus can design their medical assistance programs to cover any remaining co-payment for low-income households. In 2012, the central government included ESRD in the list of major diseases, providing an important policy guarantee and resources to promote the prevalence and quality of dialysis in China [16].

In China, the estimated annual cost of PD is less than that of HD, with a HD/PD cost ratio of 1.16 [17]. Also, PD might have advantages over HD due to its simplicity and minimal requirements for technical support and electricity. It is especially advantageous to patients living in remote and rural locations as a home-based treatment option. As a result, the PD utilization rate grew very rapidly by >20% per year from 2003 to 2008 after the implementation of a medical insurance system to cover the cost of dialysis in many big cities. In 2013, it was estimated that 46,633 patients were undergoing PD in China.

This rapid expansion of PD utilization secondary to the country's economic growth was also observed in Vietnam from 2003 to 2008, where the number of PD centers rose from 3 to 17. Apart from economic factors, other Asian countries demonstrated a growth in the PD service due to government interventions. In Taiwan, where the dialysis treatment rate remains one of the highest in the world, dialysis expenditure poses a heavy burden on the economy; its average PD utilization rate is low at around 10%. In order to reduce the medical expenditure on dialysis therapy, the government implemented a series of measures to increase the rate of PD utilization in relation to HD. It was noted that in 2004, a policy was implemented to progressively reduce the reimbursement of HD treatments in dialysis centers. In contrast, reimbursement for PD was increased while that for HD was further cut down in 2007. As a result, the number of PD patients increased by as much as 19.4% in 2007 [18]. In Thailand, all dialysis therapies had to be self-financed until the mid-1990s, whereas HD therapy in local civil servants was supported by the government. In early 2008, the government of Thailand decided to provide free dialysis services to its citizens within a controlled budget. In this regard, only PD treatment was supported by the government while citizens had to pay fully for any HD therapy, as it was realized that HD was more expensive than PD. The Thai government also made efforts to reduce the costs of PD

fluids via negotiation with providers. The number of PD patients expanded rapidly as a result of the new policy, with an estimated increase by 100% of PD patients just in the first year in 2008. In fact, Thailand's PD population continued to increase thereafter, with a prevalence rate growing from a mere 4.2% in 2006 to 23.1% in 2012 [19–21].

Issues Related to Peritoneal Dialysis in Asian Countries

Due to a lack of comprehensive renal registries and scientific publications and use of languages other than English in the publications in many developing Asian countries, it is difficult to accurately estimate outcomes related to PD in many developing countries in Asia. Some of the outcomes and PD-related complications are highlighted in the following review.

Patient Survival

Hard outcomes related to PD, such as mortality rate, vary between different Asian countries. However, variation was mainly observed between developed and developing countries. Among the developed countries with well-established renal registries, the survival rates are comparable (table 1). In contrast, survival can be very different in developing countries. On the other hand, we can see a consistency in the top causes of death, i.e. cardiovascular diseases and infections, among PD patients no matter whether they reside in developed or developing countries.

In Hong Kong, one of the regions with the highest PD penetration percentage in the world, the annual mortality rate related to PD patients (calculated by counting the number of deaths divided by the person-years exposed) was found to be decreasing with time. It was reported in the 2012 renal registry of Hong Kong that the annual mortality rate decreased from 22.23% in 2001 to 15.21% in 2011. Better dialysis care and patients' choices of either dialysis or supportive management might be the reasons behind the improvements [22].

Similar trends were observed in other Asian countries. For Australia, there has been some slight improvement in PD patient survival at 6 months and 1, 3 and 5 years from 2000 to 2011. In New Zealand PD patient survival was unchanged up to 2005, but improved for the 2006–2011 cohort [23].

In Singapore, lower survival rates were observed. The reported 1- and 5-year survival rates in a study during the

Table 1. Comparison of PD patient survival

| Country | Reference | Number of cases | Mean age, years | DM rate | Time of review | Patient survival |
|-------------|-----------------------------|-----------------|-----------------|---------|----------------|--|
| Hong Kong | Ho et al. [22] | 3,573 | 59.2 | 46% | 1995–2009 | 1 year: 91.1% 3 years: 69.6% 5 years: 50.7% 10 years: 26.7% |
| Australia | McDonald and Hurst [23] | 1,660 | n.a. | 33% | 2006–2008 | 1 year: 94% 3 years: 73% 5 years: 54% |
| New Zealand | McDonald and Hurst [23] | 412 | n.a. | 43% | 2006–2008 | 1 year: 94% 3 years: 77% 5 years: 50% |
| Korea | Jin et al. [54] | 7,423 | 58 | 45.20% | 2001–2010 | 1 year: 93.9% 3 years: 75.2% 5 years: 56.9% 10 years: 32.3% |
| Singapore | Choo et al. [24] | 1,015 | 58 | 58% | 2000–2008 | 1 year: 88.7% 5 years: 39.8% 10 years: 15.4% |
| Taiwan | Wu et al. [25] | 8,430 | 55.7 | 31.40% | 2000–2009 | 1 year: 95% 5 years: 60% |
| Thailand | Dhanakijcharoen et al. [20] | 12,753 | n.a. | n.a. | 2008–2011 | 1 year: 79% 2 years: 66% 3 years: 57% |

n.a. = Not assessed.

period of 2000 to 2008 from a major PD center were 88.7 and 39.8%, respectively. Again, cardiovascular disease and infections contributed to 80% of all mortality. The lower survival rates compared to other Asian countries were attributable to an older PD population with a higher percentage of DM patients [24].

On the contrary for Taiwan, despite the nationwide implementation of continuous quality improvement measurements since 2005, the overall dialysis patient survival was reduced in the 2000–2009 cohort in comparison to the 1990–2001 cohort. There is no significant difference in the trend between HD and PD patients. This phenomenon was explained by the authors in the analysis report by the fact that the demographic characteristics of patients entering dialysis are changing. There were more diabetic and elderly patients in the 2000–2009 cohort than in the 1999–2001 cohort. This phenomenon may have contributed in part to the decrease in survival of the 2000–2009 cohort. However, the 1- and 5-year survival

rates among PD patients were comparable to other Asian countries at around 95 and 60%, respectively. Similar to other countries, cardiopulmonary diseases and infections accounted for >70% of all mortality in PD patients [25].

We can only obtain a glimpse of other Asian countries which lack of a well-established renal registry from individual reports. For China, in an analysis of the Shanghai renal registry from 2000 to 2005, it was noted that the overall death rate (calculated by the number of deaths divided by the sum of the number of patients alive at the end of the previous year and the number of new patients diagnosed in the current year) decreased from 9.2% in 2000 to 7.5% in 2005. Cardiovascular diseases and infection remained the leading cause of death [26]. In another single-center retrospective study in which 421 PD patients were analyzed from 2001 to 2011, patient survival at 1 and 5 years was 92.5 and 74.4%, respectively [27].

For India, there is a paucity of data related to PD. As India is a large country with a vast variation in the climate,

patient characteristics and financial situation, the outcome in PD also varies. For example in a retrospective four-center analysis of survival in south Indian chronic PD patients during the period 1999–2004, a total of 309 patients were included. The study comprised 62% of PD patients who lived in the city and 38% of those who lived in rural areas. The 1- and 5-year survival rates among PD patients were around 90 and 70%, respectively. However the study was hampered by a high dropout rate up to one third of the total PD patients due to loss to follow-up, and clinical details were not available [28]. In another study by the largest PD center in a tertiary care institute located in a city of South India which included 373 patients who started PD between 2000 and 2004, the 1- and 5-year survival rates were 90 and 39%, respectively. The top causes of death were cardiovascular diseases and infections [29]. In contrast, in a single-center report from the only tertiary care hospital in the state of a mountainous state in the northern part of India providing dialysis services, PD was the sole RRT offered. A total of 60 patients were treated with PD between 2002 and 2011. The 1- and 5-year survival rates among PD patients were significantly lower at 77 and 10%, respectively. The major causes of mortality in that study were again cardiovascular, followed by infection [10]. City dwellers seem to have better survival compared to those living in towns and villages as they are financially better-off and have better access to medical care. Patients in rural areas do not have access to proper microbiology services, well-stocked pharmacies or medical care for comorbid conditions.

Cardiovascular Diseases

Based on the above studies, cardiovascular diseases and infection are the two main causes of mortality in most Asian countries. Cardiovascular diseases are common in ESRD patients, and in fact the presence of chronic kidney disease itself is a well-known independent risk factor for recurrent cardiovascular disease and mortality, even after adjustment for traditional cardiovascular risk factors [30, 31]. The mortality rate due to cardiovascular disease in ESRD patients can be as much as 15 times higher than in the general population [32, 33]. Part of the contributing causes is the increasing prevalence of DM in the PD population. From United States Renal Data System data, we observed a trend of increasing DM among dialysis patients globally, and according to table 1, up to 30–60% of PD patients in Asian countries suffered from DM. PD patients are at higher risk for either new-onset DM or worse glycemic control in existing DM because of the high glucose content of PD fluids. It was observed that

higher fasting glucose levels >100 mg/dl were associated with poorer patient and cardiovascular outcomes [34].

While some of the traditional risk factors for cardiovascular diseases, like DM and smoking, increased cardiovascular disease mortality in ESRD patients just like in the normal population, other traditional factors such as BMI, serum cholesterol and blood pressure showed a reverse epidemiology in long-term dialysis patients in that obesity, hypercholesterolemia and hypertension may appear to be protective features that are associated with a greater survival among dialysis patients [33, 35]. Less data were available concerning Asian PD patients. In a study involving 274 PD patients in a single center in Hong Kong from 2001 to 2008, it was found that the relationship between BMI and mortality was U-shaped, with higher mortality in underweight and obese patients. It was shown that there was an interaction with both DM and cardiovascular disease, such that there was an increased risk of death among obese diabetics but not among obese non-diabetics, and among obese patients with cardiovascular disease but not among those without cardiovascular disease. There was no association between BMI and peritonitis [36]. On the contrary, a prospective study in Korea involving 900 incident PD patients showed that a lower BMI was a significant risk factor for death, but an increased BMI was not associated with mortality. However, the study was limited by a shorter median follow-up period of 24 months and the long-term trend of BMI's effect on overall mortality may not have been shown [37]. Another Indian center following 328 incident PD patients found that median patient survival was statistically inferior in underweight patients compared to patients having a normal BMI. The survival of overweight PD patients was superior to that of patients with normal BMI, but not for the obese population. The reported median patient survival in underweight, normal, overweight and obese patients was 26, 50, 57.7 and 49 patient-months, respectively. It was found that obese PD patients had a significantly greater risk of peritonitis [38]. Therefore all the above studies consistently showed that underweight in PD patients conferred worse survival, and this is particularly a problem in Asia where a significant proportion of patients suffer from malnutrition. However, different outcomes were observed in obese patients. Some reasons for the difference in outcomes in obese PD patients may be due to a different definition of obesity, variable duration of the study period, wide variability in patient characteristics in different studies and the fact that BMI is unable to distinguish between fat mass and muscle mass, which obviously affects survival outcomes [35].

Since cardiovascular disease poses a high mortality risk in our PD patients, it is important to tackle both traditional and non-traditional risk factors, as well as to pay attention to the effects of residual renal function, inflammation, malnutrition and dialysis adequacy so as to improve survival among PD patients [33].

Peritonitis and Technique Survival

PD-related infections, including peritonitis, exit site and tunnel infections, are a major cause of PD technique failure as well as of morbidity and mortality of PD patients. Due to geographical, climatic and economic differences, the rate, type of causative organisms and outcomes of PD-related peritonitis varied between different countries. In general, the peritonitis rate should be no more than 1 episode every 18 months or 0.67/year at risk according to the International Society for Peritoneal Dialysis (ISPD) peritonitis guideline recommendations [39]. Table 2 shows a comparison of PD-related peritonitis rates, the most common causative organisms and PD technique survival rates between different Asian countries.

In Hong Kong, the overall peritonitis rates for CAPD improved from 22 patient-months per episode in 1999 to 35.8 patient-months per episode in 2011. There was a gradually decreasing trend for culture-negative peritonitis, which confirmed an improvement in the laboratory standards [22]. In Australia, the overall peritonitis rate did not follow a clear trend over time. Rates varied widely between centers. Methicillin-resistant *Staphylococcus aureus* was the primary organism in approximately 5% of Gram-positive peritonitis episodes. Mycobacterial infection was rare, occurring in <1% of peritonitis episodes. An interim transfer to HD was required in 3.5% and a permanent transfer to HD in 17.3% [23]. Han et al. [40] reviewed the PD-related outcomes from a single large center in Korea over a period of 25 years and observed that there was a significant improvement of technique survival in patients who started PD after 1992 compared to those who started before. This was most likely related to a decrease in the incidence of peritonitis with the introduction of Y-set and double-bag systems [40]. For Japan, there was observed to be paucity in the data collection of PD-related outcomes, so Mizuno et al. [41] retrospectively analyzed 561 PD patients (about 5% of all Japanese PD patients) from 13 hospitals in the Tokai area for 3 years from 2005; their results are shown in table 2.

In a review of chronic PD in South Asia by Abraham et al. [42], it was observed that the peritonitis rate ranged from 1 episode/27.9 patient-months in Nepal to 1 epi-

sode/19.46 patient-months in Bangladesh to 1 episode/22 patient-months in Pakistan and to 1 episode/71 patient-months in India. However, we must take note that data from these countries are mostly from a small number of cohorts of patients from single centers and may not represent the overall picture of the whole country. Additional data from other Indian centers are included in table 2. Similarly, a brief reference of the outcome in China can be obtained in the study by Zhang et al. [27].

The pattern of microorganisms for CAPD peritonitis remained relatively constant across various Asian countries with a predominance of Gram-positive organisms. However, some organisms may pose more problems in certain Asian countries. For example, tuberculosis is rare itself and also a rare organism in causing peritonitis in the Western world as well as in developed countries. However, peritonitis caused by tuberculosis is not uncommonly seen in Asian PD populations such as China and India. The reported incidence of tuberculosis in dialysis patients varies from 10 to 15% in India [43]. In the study by Vikrant over a 9-year period [10], there were as many as 15% of PD patients who developed tuberculosis, of whom 44% suffered from tuberculosis peritonitis. Early diagnosis and treatment are important measures to prevent the morbidity and mortality associated with tuberculosis peritonitis. Therefore, in prevalent areas, it is common practice to initiate anti-tuberculosis treatment in patient suffering from refractory peritonitis despite receiving broad-spectrum antibiotics, even when the results for mycobacterial cultures are still pending.

Fungal peritonitis is another cause of refractory peritonitis associated with high morbidity and mortality as well as high PD catheter removal rate [39]. It is a particular problem in areas with temperate or humid weather. The rate of fungal peritonitis is highly variable between countries, ranging from 1 to 15% [44–47]. However, in certain countries like India the rate can be as high as 14.3–23.9% [48, 49]. Yeast, especially *Candida* species, dominated all fungal peritonitis. Identified risks include advanced age, multiple comorbidities, DM and recent use of antibiotics. Due to a high associated morbidity and mortality risk, aggressive measures were suggested in fungal peritonitis cases. These include early initiation of anti-fungal treatment and prompt catheter removal. The ISPD peritonitis guidelines suggest that fungal prophylaxis during antibiotic therapy may prevent some cases of *Candida* peritonitis in programs that have high rates of fungal peritonitis [39]. A number of studies have examined the use of prophylaxis, either oral nystatin or a drug such a fluconazole, given during antibiotic therapy to pre-

Table 2. Comparison of PD-related peritonitis rates and PD technique survival

| Country | Reference | Number of cases | Time of review | Peritonitis rate ¹ | Common causative organisms | Technique survival |
|-------------|-----------------------------|-----------------|----------------|-------------------------------|---|---|
| Hong Kong | Ho et al. [22] | 3,573 | 1999–2011 | 35.8 | Staphylococcus (48.2%) Pseudomonas (35.8%) culture-negative (11.1%) | 5 years: 31.3% 10 years: 3.1% 15–20 years: 0.7% |
| Australia | McDonald and Hurst [23] | 5,515 | 2007–2011 | 20 | Gram-positive (53.4%): CoNS, <i>S. aureus</i> , Streptococci Gram-negative (23.6%): <i>E. coli</i> , Pseudomonas, Klebsiella | 1 year: 85.0% 3 years: 54.5% 5 years: 36.5% |
| New Zealand | McDonald and Hurst [23] | 1,756 | 2007–2011 | 19.4 | n.a. | 1 year: 91.0% 3 years: 66.5% 5 years: 44.5% |
| Korea | Han et al. [40] | 1,656 | 1981–2005 | 31.6 | Gram-positive (42.6%): Staphylococcus (35.2%) Gram-negative (17%): <i>E. coli</i> , Pseudomonas culture negative (37.3%) | 1 year: 94.9% 3 years: 83.7% 5 years: 71.9% 10 years: 48.1% |
| Japan | Mizuno et al. [41] | 561 | 2005–2008 | 42.8 | Gram-positive (42.7%): Staphylococcus (21.5%), Streptococcus (12.8%), culture-negative (32.0%) | n.a. |
| Japan | Nakamoto et al. [55] | 5,391 | 2003 | n.a. | | 10% dropout rate/year |
| Taiwan | Hsieh et al. [56] | 391 | 2001–2010 | 61.2 | Gram-positive (42.8%): Streptococcus > Staphylococcus Gram-negative (29%): Pseudomonas > Acinetobacter | n.a. |
| India | Vikrant [10] | 60 | 2002–2011 | 30.6 | Significant tuberculosis and fungal peritonitis risks | 1 year: 77% 2 years: 53% 3 years: 25% 4 years: 15% 5 years: 10% |
| India | Abraham et al. [28] | 309 | 1999–2004 | 30 | | 1 year: 98.6% 5 years: 93.3% 10 years: 86.6% |
| China | Zhang et al. [27] | 421 | 2001–2011 | 62.9 | Gram-positive (21.1%) Gram-negative (18.4%): fungi (13%), culture-negative (47.5%) | 1 year: 86.7% 3 years: 68.8% 5 years: 55.7% 10 years: 37.4% |
| Thailand | Dhanakijcharoen et al. [20] | 12,753 | 2008–2011 | 25.8 | n.a. | 1 year: 92% 2 years: 85% 3 years: 80% |

CoNS = Coagulase-negative staphylococci; n.a. = not assessed.

¹ Patient-months per episode.

vent fungal peritonitis, with mixed results. Programs with high baseline rates of fungal peritonitis found such an approach to be beneficial.

Discussion and Conclusion

The number of ESRD patients is growing yearly in Asia as well as globally and therefore poses a great financial burden to some countries in providing timely and quality RRTs. In many developing countries in Asia, PD offers certain clear advantages over HD, such as simplicity, reduced need for trained technicians and nurses, minimal technical support requirements, lack of electricity dependence, online water purification and home-based therapy with institutional independence, which has potential for cost saving. The overall penetration of PD is however greatly affected by individual governments' healthcare reimbursement policy and its ability to control the costs of franchised PD solutions or cyclers [50]. In order to allow more ESRD patients to have a chance to receive RRT, some Asian countries like India and China have started to manufacture PD fluids locally, with outcomes comparable to those of traditional PD fluids [3, 51]. Most developed Asian countries have comparable PD outcomes to their western counterparts, but some developing countries are still catching up with the care of PD patients and with maintaining acceptable laboratory standards. We have also observed unique aspects (e.g. socio-economic differences, different government policies, particular problems such as infections, etc.) related to PD in various Asian countries and their ways to deal with them. After all, Asia is diversified with different ethnic groups, cultures and medical practices. This highlights the importance of establishing a comprehensive renal registry, not only to compare the patterns of diseases and outcomes of renal patients with those in other countries, but also be-

cause the data collected over time are crucial to medical policy planning and resources allocation by each government [52]. There is a general lack of renal registries in Asian countries which makes an accurate estimation of the number of individuals needing RRT impossible [53]. Published data on hospital-based or individual experience are not representative of the situation across a country. Reports prepared on the basis of those presenting to hospitals for RRT are likely to be significant underestimates as many patients never come to medical attention. We hope that with more and more Asian countries starting their own renal registries, a more complete picture can be obtained in the future regarding PD practices in Asia.

The growth of PD in Asia is significant and seeing a good trend. With the practices of PD leading to a significant improvement in the outcome of PD, the socio-economic benefits of PD can be realized for end-stage renal failure patients in both urban and rural areas in the developed and developing regions of Asia. This can help to reduce the financial burden of renal failure in addressing the growing demand of more prevalent patients on dialysis. A 'PD-first' or a 'PD as first considered therapy' policy can be an overall strategy in many countries in Asia in managing renal failure patients, as shown by the examples of Hong Kong and Thailand [7, 20].

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Disclosure Statement

Philip Kam-Tao Li and Vickie Wai-Ki Kwong declare no conflict of interest.

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