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The health security systems for end-stage renal disease patients with dialysis in Hong Kong

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Abstract
The incidence and prevalence of end-stage of renal disease (ESRD) are increasing worldwide recently years. So the renal replacement therapy (RRT) cost of ESRD is strong financial burden not only for the patient and his family but also for government and society. Fortunately, there are a lot of various health security systems contemporary in Hong Kong. Thus, this review aims to systematically introduce the current health security status of RRT patients, which mainly including maintenance heamodialysis (HD) population and continuous ambulatory peritoneal dialysis (CAPD) population in Hong Kong. First, generally introduce the RRT including maintenance HD and CAPD for the ESRD patients in Hong Kong. Second, sum up the financial burdens of HD and CAPD for ESRD patients in Hong Kong. Thirdly, highlight to review the government policy and the medical security systems for CAPD and HD patients in Hong Kong. As well as finally, outlook the benefits of medical security systems for CAPD patients at Hong Kong and give the direction of further research on this major subject in the near future.

Keywords: end-stage of renal disease; continuous ambulatory peritoneal dialysis; heamodialysis; medical insurance; Hong Kong

1. Introduction
The incidence and prevalence of end-stage renal disease (ESRD) are increasing worldwide recent years. The renal replacement therapy (RRT) for ESRD patients mainly include continuous ambulatory peritoneal dialysis (CAPD) and heamodialysis (HD).In 2013,the total CAPD patients around the world was estimated to be 272 000 while that of HD was 2.25 million. So the CAPD represent approximately 11% of global dialysis patients [1]. The highest growth in the number of RRT patients is projected for Asia, which is the most population density region in the world. According to the estimation, by 2030, the use of RRT is projected to 2.162 million people with the most growth occurring in Asia [2]. For the three areas of Greater China, in mainland China, the number of dialysis patients increased about 7 folds from 2000 to 2014,and in Taiwan, the dialysis population has increased from 0.16% of the general population in 2001 to 0.3% in 2013 [3]. As to Hong Kong, the incidence of ESRD has increased from 128 per million population in 2003 to 159 per million population in 2013.The prevalence of ESRD patients on RRT under the care of the Hospital Authority of Hong Kong has increased 15% in the 5 years from 2010 to 2014.

The number of ESRD patients requiring RRT is increasing at a rapid pace in Hong Kong due to the population aging, prevalence of diabetes mellitus [1, 4] and extended life expectancy of the patients. The number of dialysis patients increased dramatically over the past 10 years, which has put a heavy financial burden on the healthcare cost. Since the dialysis is an expensive treatment modality, and the cost of managing a ESRD patient on dialysis is estimated to be 6.8-48 folds greater than the local average cost. The socioecnomic status of ESRD patient is diverse from one to another. These factors affect both the availability of treatment and the choice of dialysis modality. Because ESRD is a chronic disease, the Hospital Authority of Hong Kong, which is running on a tight budget, supports almost 95% of the RRT patients. So the therapy cost of RRT is a strong economic burden not only for the patient and his family but also for government and society.

With a total surface area of about 1106.3 square kilometers and a population of more than 7.3 million, Hong Kong is one of the most densely populated areas in the world. Despite Hong Kong's economic growth over the past three decades, compared to the Organization for Economic Cooperation and Development countries, Hong Kong has devoted a relatively low percentage of GDP to healthcare [5]. Often there is a close correlation between the number of ESRD patients who receive dialysis and the GDP per capita. Furthermore, the government financial support or the insurance company's reimbursement policy also play the critical roles as a nonmedical influence factor on the choice and use of different modes of treatment for ESRD patients. Nerver theless the ESRD patients themselves or charities spend a substantial amount on healthcare. On one hand, the public healthcare of Hong Kong is virtually free to the individual and leads the world in medical service system. On the other hand, there are a lot of health insurance systems or co-payment plans contemporary in Hong Kong. There are about 160 insurance companies from all over the world and various sorts of health charity organizations in Hong Kong. Thus, this review aims to systematically introduce the current status of medical security systems for RRT patients in Hong Kong. First, generally introduce the RRT including maintenance HD and CAPD for the ESRD patients in Hong Kong. Second, sum up the financial burdens of HD and CAPD for ESRD patients in Hong Kong. Thirdly, review the government policy of dialysis in Hong Kong and highlight the medical insurance and charity organizations for dialysis patients in Hong Kong. As well as

finally, we outlook the benefits of medical security systems for CAPD and HD patients at Hong Kong and give the direction of further research on this major subject in the near future.

2. General introduce the maintenance HD and CAPD for the ESRD patients

Briefly, the ESRD is clinically defined as progressive and irreversible kidney function failure needing the therapy of continuing maintenance dialysis or a kidney transplantation for survival. Apart from the primary glomerulo nephritis, the diabetes mellitus and hypertension become the common secondary causes of ESRD. Generally the RRT means the blood purification and kidney transplantation else. The blood purification also normally called dialysis mainly including maintenance HD and CAPD. It is well known that the obstacle of kidney transplantation is the limited donor resource. Therefore the maintenance HD and CAPD become the major approaches for ESRD patients. Anyway, the dialysis is a lifesaving but high-cost treatment for ESRD patients.

Mantenance HD is a process of purifying the blood of ESRD patient, which achieves the extracorporeal removal of waste products such as blood creatinine and blood urea nitrogen, hyperkalemia and over lode water in a state of kidney function failure. While CAPD is a continuous dialysis process in which solutes and fluid are exchanged between blood in the peritoneal capillaries and dialysis solution in the peritoneal cavity by crossing the peritoneal membrane. The HD is adapt for patients who need dialysis acutely, such as hyper kelemia, and also for many patients as maintenance therapy. While the CAPD is better for the diabetes kidney disease, ESRD combine cardiovascular disease, frail geriatric ESRD patients and hepatitis B or hepatitis C *etc.* virus infectious patients. The patients who have had a previous abdominal operation are needed to be assessed by a surgeon for peritoneal access and preferred dialysis modality is HD. Patients with refractory or relapsing peritonitis will be placed on temporary HD after their peritoneal catheters have been removed (Fig 1).Under the Hong Kong government policy, around 80% dialysis patients choice CAPD due to the economic cause. of course, patients covered by commercial insurance or capable of self-coverage have the option of different dialysis modality.

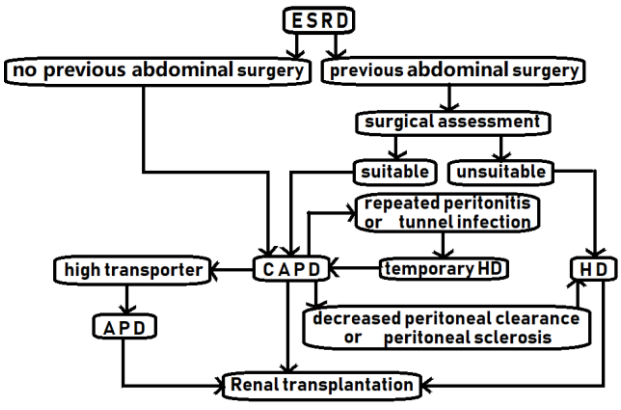

Fig 1: Schedule modle of management for ESRD patient in Hong Kong

CAPD has a long way since its introduction in 1969 in Hong Kong but remained limited until 1980 [6].The benefits of CAPD include needle-free, portable and flexible, and keeping the residual kidney function going longer than standard mantenance HD. In addition, the appropriate use of smaller exchange volumes,6L daily v.s. the standard 8L daily, in some Asia patients with smaller body size and could reduce the daily cost of CAPD without jeopardizing adequate dialysis. The major impetus of PD-first policy in Hong Kong included higher patient survival rate, preservation of residual kidney function, improve health related quality of life and gain economic advantage. Thus the success of CAPD programme can be exemplified by a high utilization rate, excellent patient and technique survival [1, 6-8], reduced complication rates and good quality of life [4].

The satistical results showed, the proportion of ESRD patients on CAPD treatment in Hong Kong, Malaysia, Thailand, Korea, Singapore, Japan, Taiwan, and mainland China are 80% [4], 63%,40%,37%,17%,6%,6% and 6%[9],respectively. So the rate of CAPD patients in Hong Kong is the highest in the world. Renal registry data indicated that in Hong Kong, the prevalence of CAPD patients increased from 501 per million people in 2010 to 546 per million people in 2014 [1].

3. The financial burdens of dialysis for ESRD patients

The provision of dialysis therapy for ESRD patients is very costly. In the USA, the ESRD programme was accounting for 6.4% of the total medicare expenditure in 2006.In Korea, the cost of dialysis consumes 3% of the total medical cost. Similarly, the renal services account for about 1% of the federal health budget in Malaysia. In Taiwan, which has one of the highest ESRD prevalence rates in the world, dialysis patients consumed more than 6.1% of the total annual spending of national health insurance in 2005 [4].In Hong Kong, the annual maintenance cost for CAPD was 12 800 USD, or 14.950 USD if including outpatient visits and in hospital treatment, whilst the figure was 30 600 USD for in-centre HD [10].

Certainly, in Hong Kong, the dialysis patients can choose to be treated at a public health sector for a normal fee (7 USD per visit) or a private nephrology clinic if paying by self-coverage or by insurance (100 USD Per visit).Because of the chronic nature of the disease, family physicians usually refer most patients to a specialist clinic in their early kidney disease stages. The estimated average monthly costs of in-centre HD in the public sector of Hong Kong is 2560 USD, while CAPD is only 1070 USD, which including consumables and drugs, erythropoietin and hospitalization owing to treatment of complications. Furthermore, a cost analysis in the year 2000 presemted that the averaged annual all-cause expenditure for a CAPD patient was only about 40% of that for a HD patient in Hong Kong [11].In other countries, for example, mainland China, United kingdom, North American, the cost of CAPD is lower than that of HD also [8].Particularly, the cost of CAPD in Hong Kong is lower than that in the USA and United Kingdom.

Additionally, the automated peritoneal dialysis (APD) utilization rate is low in most Asian Pacific countries including Hong Kong because of the expensive machine, which cost ranges from 10 000 USD in Hong Kong to 18 500 USD in Japan, while 500-6000 USD in North America. The monthly cost for APD patient is about 1800 USD in Hong Kong [12].Thus only less than 5% of CAPD patients used APD. The low utilization of APD is clearly influenced by non-medical factors, among which financial

reimbursement and the cost of APD machines and tubing for single use.

Sometimes CAPD is limited more likely by non-medical factors rather than medical factors such as reimbursement issues and healthcare insurance system pays [13, 14]. So the government's financial contribution and the healthcare insurance industry's reimbursement policy represent a nonmedical but strong influence on the choice and utilization of different treatment modality for ESRD patients in Hong Kong. The financial factors impact on not only the choice of dialysis modality but also the clinical outcome, for instance, the control rate of the complications of CAPD [15, 16]. For the dialysis patients, besides the cost of blood purification, the therapy of complication is also a huge burden[15,17-19].The other reason is that the financial resources for dialysis are still limited and many patients have to continue working to pay for their RRT costs [9].

4. The benefits of medical securities for ESRD patients on dialysis in Hong Kong

4.1. The government policy of dialysis for ESRD patients in Hong Kong

Generally speaking, the Hospital Authority of Hong Kong is statutory body responsible for managing all the public healthcare institutions at local. It has a dual track system with public and private care along each other in Hong Kong. On one hand, there are 41 hospitals, 47 Specialist Outpatient Clinics and 73 General Outpatient Clinics undergoing Hospital Authority. On the other hand, the private sector include 11 private hospitals, around 100 private clinics and more than 2000 private doctors in solo or group practice. The public health care organizations open and service to all citizens but the private sector will be on the individual choice depending on affordability. So the expenditure of the Hospital Authority of Hong Kong is highly dependent on government funding and running on a tight budget. On the contrary, the private sector perform on payment-out-pocket by patients themselves or private medical insurance.

In Hong Kong, the government spends 2.97% of GDP for public healthcare, covering 92% of all hospital admissions, while the general population spends 1.8% of GDP for private healthcare, covering 8% of all hospital admissions [20]. So only 10% of the population has healthcare insurance or receives health benefits from their employment. On the whole, Hong Kong government basically has achieved the goal that every citizen can receive lifelong holistic healthcare, and no one will be denied adequate medical treatment due to lack of means [21].

The 95% of RRT patients are treated at the 11 public renal units, the remaining patients are managed in smaller renal units in 7 private hospitals. All dialysis and transplant patients are managed by a nephrologist, there are 9.5 nephrologists per million population and one third of these are in private practice. There are a few satellite HD centres in Hong Kong because of the predominance of CAPD and the close proximity of patients' residences to regional hospitals. Each public renal unit has around 150 patients on RRT, but only in 1 or 2 renal centres this number exceeds 700 patients.

Considering the ESRD patients who switch from maintenance HD to CAPD have a great mortality risk and incur more direct medical costs v.s. patients initiated and maintained on CAPD, Hong Kong government established PD-First policy, which PD is used as the first treatment modality for appropriate patients [22]. Through a targeted assessment of peer-reviewed literature, governmental and associated websites, Hong Kong was identified as having PD-First policy. Due to the effect PD-first policy from the government, about 80% of ESRD patients in Hong Kong are treated with CAPD. All new patients entering the RRT programme running are offered CAPD as the first-line dialytic treatment [9, 10, 23].The reimbursement of both HD and CAPD cost by government is 100% in Hong Kong. In all the other regions, the cost of CAPD is 10-40% cheaper than that of HD, only in Hong Kong, where the cost of CAPD is more than 55% cheaper than that of HD. The advantage, together with the government PD-first policy and reimbursement promote to accounts for the 80% CAPD utilization rate in Hong Kong [12].

Under the current PD-first policy of Hong Kong, CAPD is provided as the first line dialysis modality unless a medical contraindication dictates otherwise. The Hospital Authority of Hong Kong only reimburse CAPD patients if there is no medical contraindication for CAPD. The ESRD patients can go to non-profit making charitable HD centre or private HD centre, by paying out of their own pockets, if they choose HD as their treatment despite being medically fit for doing CAPD [24]. It is well known that the high penetration rate of CAPD in Hong Kong is the product of the PD-first policy since the middle of 1980 [1].Thus the PD-first policy was instituted primarily for economic considerations. The PD patients in Hong Kong enjoy excellent 5-year survival of 64% for aged 20-44 and 25% for aged 65-74 [22]. It was also reported from renal registry of Hong Kong that the annual mortality rate decreased from 22.23% in 2001 to 15.21% in 2011 [25].

4.2. The medical insurance for dialysis patients in Hong Kong

In Hong Kong, the healthcare security systems usually include public healthcare security and private healthcare insurance. On one hand, the government provides healthcare for everyone at virtually no cost primarily through the public portion, which includes services for not only native citizens or permanent residents, but also nonpermanent residents. On the other hand, the commercial insurance systems for patients are abundant in Hong Kong. Particularly, Hong Kong is at an important stage in formulating detailed proposals for the Health Protection Programme, which is a voluntary and government-regulated private healthcare insurance scheme proposed in 2010.By offering value-for-money private insurance products, the programme may provide an alternative to public healthcare to those who are willing and able to afford private healthcare services, such as the middle class [26].

In the terms of private spending, the most important source was out-of-pocket payment by the patients' households, followed by employer-provided group medical benefits and commercial insurance. As the private insurance has played an increasingly critical role in private financing spending, from 2.2% of total private spending in 1989/90 to 13.9% in 2010/11[5]. So it is worth noting that private insurance will likely overtake employer benefits as the second largest private payer if the healthcare insurance market continues to expand at the current rate. For instance, the government reimbursement for the CAPD patients only include solution but except tubing in Hong Kong [20]. As well as, the maintenance HD patients and temporary HD due to the

CAPD failed patients have to pay by themselves if go to private clinic.

There are different commercial insurance programmes from different insurance companies which protect for ESRD patients in Hong Kong. We could select some critical schemes to show the normal cases. For instance, a series of insurance programmes that protect ESRD patients are provided by Prudential General Insurance Hong Kong Limited. Their insurance programmes include (1) PRU health Critical Illness Extended Care; (2) PRU health Critical Illness Multi-care Prestige; and (3) PRU health Critical Illness Protector [27]. The details see Table 1.In general, other programmes provided by Prudential Hong Kong Limited have the similar situations. The condition on kidney failure while the benefit consists of 100% of current sum assured of due programme plus face value of bonus and 100% of current sum assured of enhancer programme if any. Another example is Sun life Hong Kong that offers several life insurance programmes covering the expense of ESRD. Here we could select and show the three typical programmes including: (1) Sun Health Ultra Care/Sun Health Maxi Care; (2) Critical Medical Care Insurance Plan II; and (3) Sun Health Medical Premier [28].The details please see Table 1.

Apart from the Projects mentioned above, we could introduce one policy which is detailed in its structure for China Life Insurance (Overseas) Company Limited in Hong Kong. Their programme titled Critical Illness Multiple Protector, also for chronic and irreversible kidney failure patients. The benefits that patients aquaired see the Table 1.After the claim payment of the benefit, premiums for the series will be waived. The maximum benefit amount is 180% of the original sum assured of the basic plan. The benefit payment should deduct the claim being paid. Besides, this policy also provides a Multiple Critical Illness Benefits including, 100% of the original sum assured of the basic plan for the second claim and the 3rd claim, respectively, 200% and 300% of the original sum assured of the basic plan for the fourth and the fifth claim. Further more, each covered critical illness is eligible for one claim. That is to say, the patients can only be compensated for one time. Should it is not the first claim, it will be compensated according to the Multiple Critical Illness Benefit. The maximum benefit amount is 700% of the original sum assured of the basic plan [29].

At last, from Mass Mutual Asia Limited, it could be found a policy for kidney failure patients with three sections of benefits plans, titled Critical Illness Benefit. Details see the Table 1.Besides the basic benefit, the Critical Illness Extra Benefit offers a lump-sum benefit which is an extra protection rather than an advance from patient life insurance policy, and Critical Illness Double Benefit goes further to offer the best possible protection against the unpredictable for patient. The lump-sum benefit, which is not an advance from insurance policy, is payable immediately upon diagnosis of critical illness. Also, during the rehabilitation period, the patient will receive an Extra Monthly Benefit equivalent to 5% of the Sum Insured from the first month of diagnosis, up to a maximum of 30 months. Finally, Critical Illness Double Benefit provides Extra Life Coverage. This amount, equivalent to the Sum Insured less any critical illness lump sum benefit paid, is payable in the event that the worst happens for whatever reason[30].Therefore, all these insurance policies offered vital protection to ESRD patients, which ensured them to get treatment and reduce finance pressure. This is of great importance for patient's family and makes sense to the whole society.

Additionally, some hospitals such as Hong Kong Adventist Hospital, in partnership with a majority of local and international insurance carriers as well as third party administers, is able to offer a direct billing service to the patients. However, it may still be necessary for patients to cover the co-payment upon checkout. The system support and help patients for more convenience.

Table 1: The main healthcare insurance plans for ESRD patients on dialysis in Hong Kong

the name of Plan	Supplied Limited company	For condations	Benefits for insurant patient	Reference number
PRU health Critical Illness Extended Care	Prudential General Insurance Hong Kong Limited	Kidney failure	100% of current sum assured of PRU health Critical Illness Extended Care + face value of Special Bonus (if any) + 100% of current sum assured of Critical Illness Care Enhancer (if applicable)	29
PRU health Critical Illness Multi-care Prestige	Prudential General Insurance Hong Kong Limited	Kidney failure	100% of current sum assured of PRU health Critical Illness Multi-care Prestige + 100% of current sum assured of Critical Illness Prestige Enhancer (if applicable)	29
PRU health Critical Illness Protector	Prudential General Insurance Hong Kong Limited	Kidney failure	100% of current sum assured of PRU health Critical Illness Protector + face value of Terminal Bonus (if any) + 100% of current sum assured of Crisis Protection Enhancer (if applicable)	29
Sun Health Ultra Care/ Sun Health Maxi Care	Sun life Hong Kong	Kidney failure	In the first 10 policy year, the benefit is the higher one between 150% current sum assured + face value of Special Bonus (if any), and total premiums paid - any benefit paid. From the 11th policy year onwards, the benefit is the higher one between 100% current sum assured + face value of Special	30

			Bonus (if any), and total premiums paid - any benefit paid.	
Critical Medical Care Insurance Plan II	Sun life Hong Kong	Kidney failure	100% of the sum assured of the policy + 40% life stage benefit + 50% Major Medical Care Benefit + 100% Death Benefi	30
Sun Health Medical Premier	Sun life Hong Kong	Kidney failure	Full hospitalization and surgical expenses coverage up to HKD20 million per year with no limit on confinement hours	30
Critical Illness Multiple Protector	China Life Insurance (Overseas) Company Limited in HK	Chronic and irreversible kidney failure	Prior to the policy anniversary immediately following the insured's 66th birthday, the benefit is 180% of the original sum assured of the basic plan + terminal dividend (if any) - all indebtedness (if any) and claim amounts paid out. In the period between the policy anniversary immediately following the insured's 66th birthday and the policy maturity date, the benefit is 100% of the original sum assured of the basic plan + terminal dividend (if any) - all indebtedness (if any) and claim amounts paid out.	31
Critical Illness Benefit	Mass Mutual Asia Limited	kidney failure	According to the issue age, the maximum benefit varies from 100% of the sum insured of the basic plan / term life supplementary benefit to US$ 200000 for the additional plan	32

4.3. The contribution of charity organizations for CAPD patients

In Hong Kong, the annual admission rate for new dialysis patients remains high, which is 100 per million general population. About 95% of these patients have full comprehensive coverage of dialysis expenses by government resources, whereas the cost of treatment for the rest is covered by individual earnings or by charity.

The Hong Kong Kidney Foundation was established in 1981 with two satellites HD centre now. With the growth of CAPD patients, this organization developed a programme to subsidize APD at home. The other charity organization is the Hong Kong Kidney Patients Trust Fund established in 1985.The Fund provided APD machines to the ESRD patients. The provision of APD and ultraviolet disinfection by these two charity organizations led to decrease in the peritonitis rate dramatically among all PD patients [7].

5. Outlook the benefits of medical insurance for dialysis patients in Hong Kong

Along with the increased dialysis population, ways needed to cope with the heavy financial burden are presented and faced before the physicians, government officials, healthcare policy makers, medical insurance actuaries, even society workers. Basicly, a variety of measures should be proposed to limit expenditures on treatment of ESRD, which including early detection and medical intervention for prevention and retardation of the progression of chronic kidney disease. Apart from these, it also include promotion of kidney transplantation and use of renal palliative care service. As the nonmedical factor, in the point of economic view, the other important measure is to select the most cost-effective mode of dialysis. As well as to increase utilization of home based dialysis therapy, such as CAPD [23,31], which is the most cost-effective than HD and at the same time provides patient empowerment with at least as the good outcomes.

Generally, for a PD-first policy in Hong Kong, the key impact elements addressed systematically the government policies, including financial factors, healthcare professional education, dialysis modality and patient related factors. The government reimbursement policies play a crucial role in cost containment for dialysis patients. But actually the research studies, publishements and open big data or metadata on medical economic and healthcare insurance field are limited. When possible, the economic evaluation on ESRD patients with dialysis should include information on patients economic level, quality of life, education background, emotion state and employment status. To facilitate patient-centered care, it is hoped, the optimal healthcare security systems coverage, health and medical systems, economic status and quality of life will be assessed together. Along with the development of actuarial theories and application for some new digital devices aid, such as Cloud technique, the results will give information and big data to the government and policy making groups for the dialysis focused policies to improve the ESRD patients clinical outcomes. Further more, based on the model of internet plus medical care, the insurance group would provide or arrange managed care for health insurance. This innovation will support some patients who suffered chronic diseases for a valid, maintenance and convenience gateway.

To make a long story short, the results of medical burden statistics and healthcare insurance can deliver us the direction to save the limitd hygiene resouces positively in a long run, and help to reduce financial stress of the government. It can also support the ESRD patients with CAPD or HD to go back family and work, as well as back to community and society. The Holy Grail is the ESRD patients on dialysis will receive the most benefis and best outcomes both on physical and on sychological.

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