ANALYSIS OF THE ROLE OF PERITONEUM CHARACTERISTICS AND GLUCOSE CONCENTRATION IN DRAIN VOLUME IN CAPD PATIENTS IN CCI CIKINI HOSPITAL, JAKARTA

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ABSTRACT

Fluid output in patients undergoing CAPD is influenced by glucose inCAPD fluid which acts as an osmotic agent. On the other hand the characteristics of the peritoneum indirectly affect ultrafiltration through the rapid or slow diffusion of glucose from the dialysate into the plasma, thus affecting the difference in osmotic pressure. This study aims to analyze the role of glucose concentration and peritoneal characteristics of fluid output in patients undergoing CAPD. The study used Retrospective cross-sectional approach with consecutive data collection methods sampling . All data are sourced from medical records and patient CAPD diaries from 2005 to 2010. Peritoneal characteristics are determined based on PET examinations conducted at PGI Cikini Hospital. Measurement of fluid output was carried out for 7 days based on the patient's CAPD diary, for a period of 1 day to 6 months after PET examination. The results of the study show different mean output of fluid in the dialysate with different glucose concentrations and different peritoneal characteristics. T test results showed differences between the average output of dialysate with a glucose concentration of 1.5% and 2.5% on the day and night (p <0.05) ANOVA test results showed differences between the mean output between the high transporter with high average transporter and low average transporter, high average transporters with high transporters , low average transporters with high transporters (p <0.05) It can be concluded that glucose concentrations and peritoneal characteristics are equally responsible for fluid output in patients undergoing CAPD , but the dominant role cannot be concluded.

Keywords: peritoneal characteristics, glucose concentration, output, CAPD

INTRODUCTION

Continuous Ambulatory Peritoneal Dialysis (CAPD) is a modality of Peritoneal Dialysis (PD),which is one of the replacement therapies for End Stage Renal Disease (ESRD).[12] CAPD is a dialysis technique using the peritoneal membrane as a dialysis membrane. Peritoneum classified based on the Peritoneal Equilibration Test (PET) examination. PET categorizes peritoneum into four classifications, namely; high transporter, high average transporter, low average transporter and low transporter[13, 14]. Glucose in CAPD fluid acts as an osmotic agent, which results in a difference in osmotic pressure which affects ultrafiltration or fluid transfer during CAPD

The difference in osmotic pressure caused by glucose concentration is one of the determining factors for fluid transfer across the peritoneal membrane during CAPD. The higher the glucose concentration the greater the ultrafiltration caused.Meanwhile the use of glucose as an osmotic agent has advantages and also limitations, because glucose is not a perfect osmotic agent, especially for long-term use.On the other hand the characteristics of the peritoneum indirectly affect ultrafiltration through the

rapid or slow diffusion of glucose from the dialysate into the plasma, thereby influencing the difference in osmotic pressure.

Therefore to achieve a stable fluid balance, the CAPD fluid glucose concentration and characteristics peritoneum should be equally considered. It's just that in Indonesia not all patients undergoing CAPD have known peritoneal characteristics.This is because there are still very few hospitals that conduct PET examinations.Besides that CAPD patients are less likely to meet health professionals than they are with hemodialysis (HD) patients, so as to obtain adequate fluid output,generally patients modify the use of CAPD fluids which is more hypertonic.The research question posed in this study is there a more dominant role between characteristics peritoneum and glucose concentration to expenditure?

RESEARCH METHODS

This research was conducted in the Renal unit of PGI Cikini Hospital Jakarta, from May 10 to June 11, 2010. The design in this study was crosssectional, with a retrospective approach.Data were obtained from medical records and CAPD diaries, which originated from 2005 to May. 2010, with a sample of 53 people.The sample in this study was taken by consecutive method sampling with inclusion criteria; CAPD patients that has been tested for PET,uses CAPD fluid with a glucose concentration of 1.5% and / or 2.5% with a volume of 2 liters and fluids changes 4 times /day, and having a CAPD book up to 1 year after the PET examination date.

Before the requesting approval for the patient involved in the study, the researcher provided information related to the research. Agreement signed patients was characterized by a consent form and willing to lend a logbook CAPD for materials research.After that, it is continued by recording data from the respondent's CAPD diary on the recording sheet.The documented data are: name, date, CAPD fluid glucose concentration, time of completion of the CAPD fluid entry, time to start dialysate,output and fluid balance every turn.

Record of fluid output is done for one week, starting (first day) one day after PET inspection, or the closest date after PET inspection within one year.Next is recording the data from the medical record which includes PET examination results, PET examination dates, blood sugar levels

and serum albumin.Blood sugar levels used are the results of laboratory tests, in the same week,Whereas the results of laboratory tests of serum albumin in the same month output data from the CAPD diary to be used.

Research result

Table 1. Characteristics of Respondents

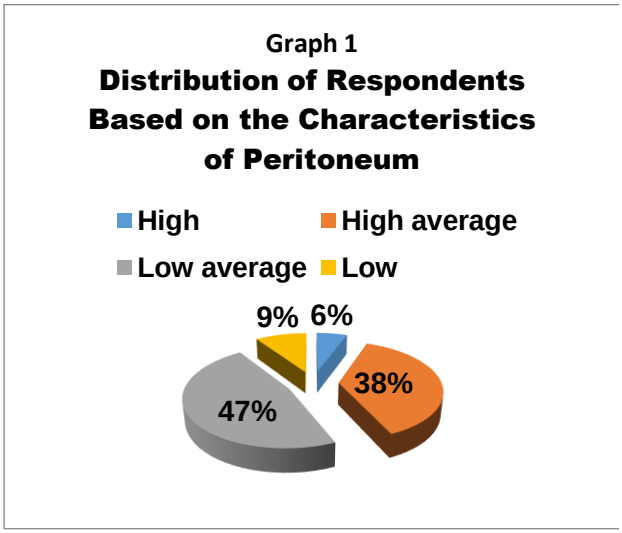
Gender (%)	
Male	56,6 (30)
Women	43.4 (23)
Age	56.02 ± 12.57
(Mean ± SD)	52,56 - 59,48
95% CI	25 - 78
Min - Max	
Blood Sugar	149.17 =
(Mean = SD)	67.09
CI95%	130,68-167,66
Min-Max	72-327
Albumin	
(Mean ± SD)	3.31 ± 0.62
95% CI	3.05 - 3.57
Min - Max	2.0 - 4,50
Time after PET	
(Mean ± SD)	10.74 ± 31.11
95% CI	2.16 - 19.31
Min - Max	1 - 178
Liquid Expenditures	
Morning	236.75 ±
(Mean ± SD)	125.91
95% CI	202.04 -
	271.45
Min - Max	14.29 -
	721.43
Afternoon	302.47 ±
(Mean ± SD)	757.14
95% CI	260,51 -
	344,42
Min - Max	70.00 -
	757.14
Afternoon	233.73 ±
(Mean ± SD)	124.07
95% CI	124.07
Min - Max	0 - 707,14
Night	306.16 ±
(Mean ± SD)	167.05
95% CI	260,12 -
	352,21
Min - Max	16,67 -
	678,57
Cumulative	1079.10 ±
(Mean ± SD)	441.07
95% CI	957,53–
	1200,68
Min - Max	16,67 -
	678,57

Characteristics of respondents in this study can be seen in table 1.

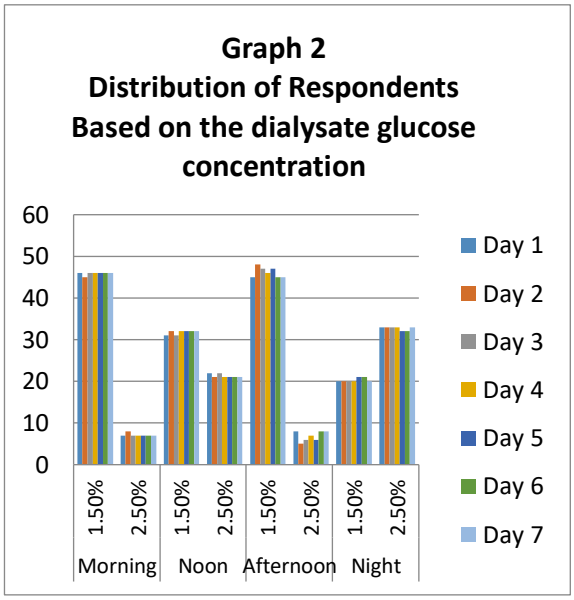
Distribution of respondents by sex shows that most of the respondents are male, that is equal to 56.6%, with an average age is

56.02 years.The youngest is 25 years old and the oldest is 78 years old.Blood sugar levels are above normal value,with the average of 149.17 mg%, where as the mean serum albumin of 3.31 g / dl CAPD respondents involved in this study were within a period of 10.74 days after PET examination(table 1).

Distribution of respondents based on Peritoneum characteristics indicate that the peritoneum characteristics of respondents are generally average namely the low average and high average.(Graph 1)



Most of the respondents used CAPD fluids with a glucose concentration of 1.5%, especially in the morning and evening. During the day the distribution of the use of glucose concentrations of 1.5% and 2.5% was quite even, while at night the respondents used more fluids. CAPD with a glucose concentration of 2.5% (Graph 2)



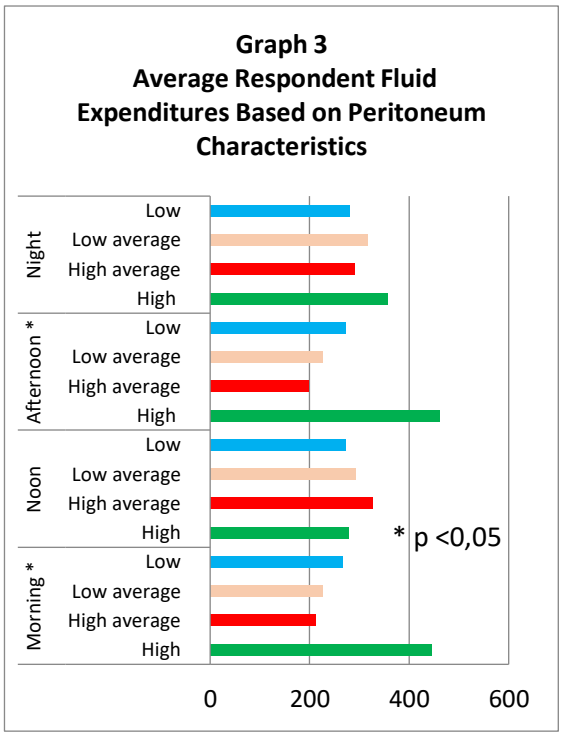
Most respondents regulates the use of glucose concentration based on patterns A and B. The results of the data analysis also shows a small portion of respondents did change the pattern, which means replacing the CAPD fluid glucose concentration of 1.5% to 2.5% or vice versa between 4 times exchange(table 2).

Tabel 2 Distribution of Respondents Based on The Pattern of Glucose Use

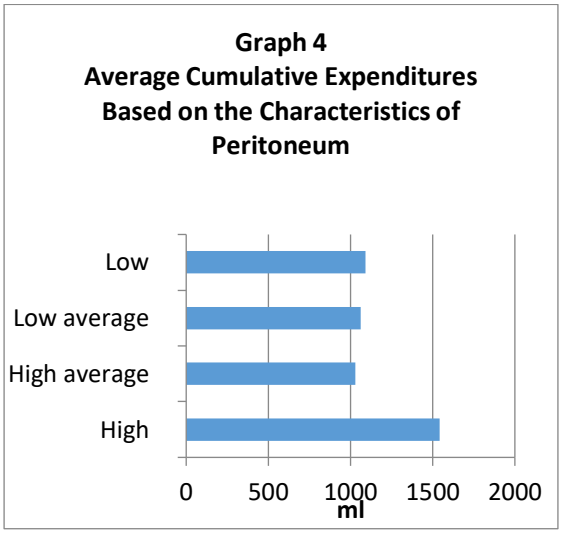
Pattern	Morning	Noon	Afternoon	Night	Freq.
A	1.5	1.5	1.5	1.5	17
B	1.5	2.5	1.5	2.5	14
C	1.5	1.5	1.5	2.5	11
D	2.5	2.5	2.5	2.5	3
E	2.5	1.5	2.5	1.5	1
F	1.5	2.5	2.5	2.5	1
G	2.5	2.5	1.5	2.5	1
Change pattern					5
Total					53

Output fluids at each change occur most at night, minimal in the afternoon. In the afternoon, the lowest output of liquid is 0 ml, which means that ultrafiltration and absorption during dwell time occur as large, so that the balance of fluid is 0 ml. While the highest average expenditure in the afternoon amounted to 707.14 ml, which means that during the dwell time 707.14 ml of liquid from the net ultrafiltration was released as a drain volume, also called the negative balance (tabel 1).

The results of the analysis show that there are differences in mean fluid output between the four characteristics of peritoneum. The average fluid expenditure is mostly in the high transporter, which occurs every exchanges except during the daytime, while the average fluid expenditure varies at least between the high average transporter and the low transporter. Further analysis showed a significant difference in mean fluid output between the four peritoneal characteristics in the morning and afternoon (p value <0.05)Significantly different groups are high transporters with high average transporters and low average transporters, high average transporters with high transporters, low average transporters with high transporters. The mean fluid output during the day and night did not show a significant difference between the four characteristics of peritoneum(graph 3).



The highest number of respondents' cumulative liquid expenditure is also seen in the high transporter(graph 4). .



The results of data analysis on the role of CAPD fluid glucose concentration variables with fluid output showed that the mean fluid output in respondents using CAPD fluid with 2.5% glucose concentration was greater than those using 1.5% glucose concentration. This difference can be seen every time you change fluids, namely in the morning, afternoon, evening and night. Further analysis appears there was a significant difference between the mean output of respondents who use CAPD fluid with a concentration of 1.5% and 2.5% on the day and night (p <0.05). The mean output of fluids in the morning and evening did not show a significant difference between respondents with the use of different glucose concentrations. (tabel 3)

Tabel 3

Average Respondent Fluid Expenditures Based on the Dialysate Glucose Concentration

	glucose concentration	Mean	SD	n	SE	p value
Morning	1,50%	229,33	130,56	45	19,46	0,28
	2,50%	286,12	95,46	7	36,08	
Noon	1,50%	243,39	129,26	31	23,22	0,000
	2,50%	389,8	147,48	21	32,18	
Afternoon	1,50%	220,26	126,55	45	18,86	0,16
	2,50%	303,14	83,11	5	37,17	
Night	1,50%	243,03	174,61	20	39,05	0,03
	2,50%	344,39	152,46	33	26,54	

The results of the correlation analysis of fluid and blood sugar expenditure showed a weak relationship in the morning, but in the afternoon, day and night did not show closeness, but all had a negative pattern . While the correlation of fluid output with serum albumin showed a strong relationship at night and in the morning, also the overall pattern was negative . While the correlation analysis shows that there is no closeness between the output of fluid and the time after PET examination, but it has a negative pattern, which means there is a tendency that the longer the time after PET examination the less fluid output.

Discussion

Most of the patients who underwent CAPD involved in this study were 56.24 years old, with age range between 25 to 78 years old. These results illustrate that renal replacement therapy with CAPD modalities can be used on all ages. Patients with

various levels of age can learn to do CAPD, as well as for elderly patients , if they do not experience dementia or visual impairment. But this situation is not an absolute contraindication, if indeed CAPD is needed it can still be carried out, for that we need help from family or other people who can help patients in doing CAPD at home.

The most commonly used CAPD glucose concentration by respondents was 1.5% in the morning, afternoon and evening. CAPD fluid with a glucose concentration of 2.5% is quite widely used in the afternoon and most at night. This is parallel with the description of the pattern of use of liquid CAPD based on fluid turnover time which describes dwell time.In theory, the concentration of glucose that is generally used is 1.5%, especially in the morning, afternoon and evening, which is at dwell time of 4-6 hours. While CAPD fluid with a glucose concentration of 2.5% is generally given at night, due to a longer dwell time , which is 8-10 hours. Hypertonic CAPD fluids are also used to obtain more expensed expenses. 4,6

Glucose is a well-known, relatively cheap and safe osmotic agent, 11 is also a source of calories, however glucose is not a perfect osmotic agent. Glucose acting as an osmotic agent can cause hyperglycemia, dyslipidemia, obesity, and damage to the peritoneal membrane in the long term, either directly or through glucose degradation products (GDPs). 2 The higher the glucose concentration there will be more GDPs formed. 2 GDPs are toxic, formed during heat sterilization and CAPD liquid storage. The peritoneum that is exposed to this toxin in the long term, can cause it changes in peritoneal morphology which is characterized by loss of mesothelial cells, interstitial fibrosis, vasculopathy, and neovascularization . as a result there is an increase in the transport of solutes with small molecular weights and glucose, which in turn causes a progressive decrease in ultrafiltration . 4,6,11 Therefore it is necessary to be careful in determining the glucose concentration to be used.

The amount of disbursement of the respondent's fluids , at most at night, was 306.16 ml, the afternoon was 302.47 ml , although the number of differences was not too large . The more amount of fluid output at night and during the day can be explained by the use and regulation pattern of glucose concentration . In the evening and afternoon, the most commonly used CAPD fluid glucose concentration is 2.5%,

so the average output of fluid is greater than in the morning and evening.

The difference in the expenditure of liquid which is not too large at night and during the day, can be due to differences in dwell time . Dwell time at night ranges from 8-10 hours, while afternoon4–6 hour. Dwell time affect net ultrafiltration, Mujais and Vonesh(2002) showed a decrease in ultra filtration net after the fourth hour, so that at night with a dwell time ranging from 8-10 hours, after four hours ultrafiltration will be reduced but the liquid absorption continues until the next CAPD exchanges. This situation can cause fluid output (drain volume) at night to be not too much.

The study also showed respondents who used CAPD fluid with a glucose concentration of 2.5% average expenditure fluid was greater than glucose concentration 1.5%. This difference is mainly seen during the day and night. Glucose is an osmotic agent, causing dialysate fluid to be hypertonic when compared to blood. This situation results in differences in the osmotic pressure between the dialysate in the peritoneal cavity which is hypertonic and the blood in the peritoneal capillaries is relatively hypotonic, thus affecting ultrafiltration or fluid transfer during CAPD. 5.8

But on the other hand glucose as an osmotic agent, has a low reflection coefficient value so that the difference in osmotic pressure caused by glucose quickly disappears. This decrease in osmotic pressure occurs because fast glucose diffuses from the dialysate fluid into the peritoneal capillary. 2 Therefore the higher the glucose concentration of CAPD fluid will be higher and the longer the difference in osmotic pressure between dialysate and blood can be maintained, so that it continues to have an effect on ultrafiltration. This situation is seen in the use of CAPD fluid with a 2.5% glucose concentration that is widely used in the evening and night , so that the average fluid expenditure is more.

The results of the data analysis further prove that glucose concentration plays a role in fluid output, there is a significant difference in the mean expenditure of fluid between dialysates with glucose concentrations of 1.5% and 2.5% at day and night (pvalue <0.05). But in the morning and evening, the difference is not too big. This can be caused by a dwell time more length, which is influenced by work, social activities or other activities undertaken in

the respondent's daily life. Although it can be assumed that dwell time in the morning, afternoon, and evening ranges from 4 to 6 hours, in this study no deep assessment of the respondent's dwell time was conducted .

Besides that, when compared with the results of respondent characteristics based on glucose concentration, it was seen that in the morning and evening, the respondents mostly used CAPD with a glucose concentration of 1.5%. As previously explained, ultra filtration net at a 1.5% glucose concentration will decrease after the fourth hour . 6.9 The amount of ultrafiltration net will increase slowly if there is no reabsorption of the peritoneum, especially through lymphatic.

Reabsorption of the peritoneum persists and will reduce intraperitoneal volume throughout the dwell time . 6 Therefore after the fourthhour the reabsorption of the liquid will be greater than the ultrafiltration, thus if there is an addition of dwell time the end result is a decrease in the amount of liquid coming out. The difference in osmotic concentration caused by glucose is generally maximal at the onset of PD and decreases over time, because of the dilution of glucose by the output and also diffusion from glucose dialysate into the blood. 2 This situation is certainly inseparable from the role of the characteristic peritoneum in influencing glucose diffusion.

Most of the peritoneum characteristics involved in this study are average, namely low average and high average . While the high and low transporters are far fewer in number, the results of other studies also show the same thing even in different percentages. 8 Based on the characteristics of the peritoneum, it can be stated, in general, respondents involved in this study are ideal for substitution therapy with CAPD, because high average transporters and low average transporters provide good dialysis and ultrafiltration. 4

The mean cumulative fluid expenditure based on peritoneal characteristics also shows differences. If it is sorted according to the most fluid output from is as follows; high transporter, low transporter, low average and high average. In general, the highest expenditure of liquid based on peritoneum characteristics is low transporter, low average, high average , and high transporter . 8 In theory, ultrafiltration on high transporter is not adequate. 4

High transporters have a large effective peritoneal surface area or high membrane

permeability, so that the osmotic pressure difference rapidly reduced due to rapid glucose diffuses into the plasma. This situation will cause low ultrafiltration. But in this study, the expenditure of high transporter fluids is relatively more than the other types of transporters , either in the cumulative amount or at each fluid change, except during the day. This relatively more expenditure of fluids, according to the researchers can be caused by several factors including the role of residual kidney fuction (RKF).

The research conducted by Konings, et al (2003) show the volume of ultrafiltration of the peritoneum is inversely proportional to RKF, the smaller the RKF the greater the volume of peritoneal ultrafiltration, which means the output of fluid was also greater. When referring to the study , a larger output of the high transporter can be caused because it decreases or there is no more RKF left. This study also shows the estimation of the fluid output intervals in the range of negative balance and a positive balance. If this estimate is compared with theory and previous research, it may be possible for the population to find a balance of fluids that differ significantly in individuals different from the peritoneal membrane - both high transporters .

Besides that hypoalbuminemia can also be the cause of the large amount of fluid secretion in patients undergoing CAPD . Based on the results of observations of researchers on respondents with this type of high transporter obtained 2 of 3 respondents experiencing hypoalbuminemia while others do not know the value of serum albumin. In high transporters, the protein in the dialysate is high so that serum albumin levels are low. Furthermore, patients with hypoalbuminemia have low oncotic pressure and ultrafiltration tends to be higher. 2

The average cumulative fluid expenditure in respondents with the average transporter peritoneum is the lowest when compared to other peritoneal transporters, but still in accordance with the estimated reference of fluid output.Twardowski (1989) states that high average and low average peritoneum provides good ultrafiltration . 4 This situation is also seen in this study where the standard dosage of CAPD expenditure of fluid in the low average and high average is not too much different.

Output inthe low transporter is second only to high transporter. Peritoneum The low transporter peritoneum has a low permeability membrane or small effective

peritoneal surface area, so that the osmotic pressure difference doesnot rapidly reduced because glucose doesnot quickly diffuses into the plasma. This situation causes excellent ultrafiltration, but dialysis is poor, so high-dose CAPD is needed . 4

If again referring to different sources can be seen in the low transporter, to get the maximum ultrafiltration it takes a longer dwell time.6,8This is the reason for this study that the average fluid expenditure in the low transporter is relatively almost the same at the turn of the liquid morning, afternoon and evening. Whereas at night more fluid is released because of the longer dwell time , which is 8-10 hours.

A further analysis of fluid secretion based on peritoneal characteristics showed a significant difference in mean fluid output in the morning and evening (pvalue <0.05). But during the day and night there is no difference in fluid expenditure which is significant between the characteristic types of peritoneum, as well as the release of cumulative fluid. The results of this data analysis when compared with the characteristics of respondents based on glucose concentration, it is seen that the use of glucosa 2.5% is more used in the day and night. According to researchers the hypertonic CAPD fluid may play a more dominant role in fluid output than peritoneal characteristics. Therefore, further research is needed to answer this assumption.

The mean blood sugar level in this study was 149.17 mg%. In theory, glucose absorption that occurs in patients undergoing CAPD can cause hyperglycemia in patients who suffer from diabetes or who experience impaired glucose in tolerance. 13Statistical analysis shows that there is a strong relationship between blood sugar levels and output in the morning, and the overall pattern is negative. These results indicate that there is a tendency for higher blood sugar levels to be less fluid.

The difference in osmotic pressure between the dialysate in the peritoneal cavity and the blood in the peritoneal capillary will be reduced if there is hyperglycemia. Systemic hyperglycemia can affect fluid secretion with reduced osmotic gradient differences. 6 Because ultrafiltration depends on the difference in glucose between the peritoneal membrane. But further studies need to be done to see other possible factors that influence the closeness of the relationship between blood sugar levels and output.

The mean albumin serum of respondents in this study was 3.31 g / dl , with ranges between 2.00–4.5 g / dl . During the CAPD process one of the physiological elements which is also wasted through dialysate is protein, and 75% of the missing protein is albumin . 10 Albumin is a large molecular weight protein and utilizes large pores (large pores) to move across the peritoneal membrane. 8 The average albumin release through dialysate is 9 g / day, hypoalbuminemia is generally minimal if protein intake is adequate . 2

Albumin is the main protein in human plasma 10 with one of its functions regulating oncotic pressure in blood vessels. Oncotic pressure acts to maintain fluid in the blood so that it is in contrast to ultrafiltration. Further data analysis in this study showed a moderate relationship between expenditure of fluid with serum albumin in the afternoon, but was very weak in the morning, afternoon and evening and had a negative pattern . This means that there is a tendency for lower albumin levels to be more fluid. As stated, patients who experience hypoalbuminemia have low oncotic pressureand ultrafiltration tends to be higher. 2 But further studies need to be done to see the possibility of other factors that influence the closeness of the relationship.

Most of the CAPD daily records of respondents involved in this study were within 1 day up to 170 days after the PET examination, with an average of 10.74 days. PET is generally examined after one month the patient underwent a CAPD catheter implant, or after the patient's condition is stable. In this study the time after PET indirectly gave a long description of the respondents having undergone CAPD, where the more days after PET examination meant the longer the patient had undergone CAPD. In general, peritoneal transport is stable over time, but studies in a small group and in a short follow-up period show that in some patients there is a change in peritoneal transport . 3 The results of the data analysis further show that there is no closeness in the relationship between expenditure of liquid and time after PET but has a negative pattern. This means that there is a tendency for the longer to undergo CAPD, the less fluid output. This shows that the tendency to reduce fluid expenditure over time needs to be further assessed .

Conclusion

The researcher concluded that the characteristics of the peritoneum and CAPD fluid glucose concentration equally affected fluid secretion in patients undergoing CAPD. The glucose concentration commonly used is 1.5% with peritoneal averagecharacteristics. Expenditure offluid in the use of CAPD with a glucose concentration of 2.5% more than 1.5%. There are differences in mean fluid output between respondents with different peritoneal characteristics, especially between high transporters and high average transporters and low average transporters; high average transporter with high transporter; low average transporter with high transporter.. More extensive research is needed to assess whether there is a more dominant role between peritoneal characteristics and CAPD fluid glucose concentration.

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