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Establishment of a prediction model for early and mid-term complications for patients undergoing catheter insertion for peritoneal dialysis

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Abstract

Objective: To investigate the factors involved in early and mid-term complications after catheter insertion for peritoneal dialysis and to establish prediction models.

Methods: A total of 158 patients with peritoneal dialysis in the Department of Nephrology of our hospital were retrospectively analyzed. General information, laboratory indices, early complications (within 1 month after the operation), mid-term complications (1–6 months after the operation), and other relevant data were recorded. Multivariate logistic regression analysis was performed to establish a prediction model of complications and generate a nomogram. Receiver operating characteristic (ROC) curve analysis was used to evaluate the efficacy of the model.

Results: Among the patients, 48 (30.8%) had early complications, which were mainly catheter-related complications, and 29 (18.4%) had mid-term complications, which were mainly abdominal infection and catheter migration. We constructed a prediction model for early complications (area under the curve = 0.697, 95% confidence interval: 0.609–0.785) and mid-term complications (area under the curve = 0.730, 95% confidence interval: 0.622–0.839). The sensitivity was 0.750 and 0.607, and the specificity was 0.589 and 0.765, respectively.

Conclusions: Our prediction model has clinical significance for risk assessment of early and mid-term complications and prevention of complications after catheterization for peritoneal dialysis.

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Keywords

Peritoneal dialysis, catheterization, early complication, mid-term complication, prediction model, abdominal infection, catheter migration

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Introduction

Peritoneal dialysis has become the preferred alternative treatment for end-stage renal disease because of its advantages, including low cost, simple technique, protection of residual renal function, minimal effect on normal work, and stable hemodynamics.[1] Studies have shown that the 5-year survival rate is not significantly different between peritoneal dialysis and hemodialysis.[2] Although peritoneal dialysis is a safe and effective alternative treatment for renal disease,[3] it may still cause a series of complications. The success of catheter insertion in peritoneal dialysis is associated with the outcome of patients after initiating peritoneal dialysis. Serious complications of catheterization in peritoneal dialysis include bleeding, visceral injury, infection, and catheter-related complications.[4,5] Common catheter-related complications include leakage around the catheter, catheter displacement, catheter blockage, and tunnel infection. Once complications occur, the effectiveness of dialysis is affected, and surgical adjustment may be required in severe cases. Therefore, for successful peritoneal dialysis, the incidence of complications needs to be reduced and the patency of catheters needs to be prolonged.[6]

Peritonitis and catheter-related complications are the main factors affecting the prognosis of patients on peritoneal dialysis.[7] The incidence of catheter migration can be as high as 48%,[8] and leakage occurs in up to 20% of patients on peritoneal dialysis.[9] To reduce the complications of peritoneal dialysis, previous studies mostly focused on improving the catheterization method.[10–12] However, there have been few studies on the factors that affect postoperative complications, and most of them are limited to peritonitis.[13–15] Factors that are associated with overall complications after catheter insertion for peritoneal dialysis are unclear. To examine the risk factors of complications after inserting a catheter for peritoneal dialysis, we analyzed the early and mid-term complications of patients after initiating peritoneal dialysis. We also established prediction models for the risk of early and mid-term complications, which could be helpful for prevention and diagnosis of complications in patients on peritoneal dialysis.

Materials and methods

Patients

This was a retrospective study. We analyzed the data of patients who underwent catheter insertion for peritoneal dialysis from January 2017 to December 2019 in the Department of Nephrology, the Third Affiliated Hospital of Soochow University. The Ethics Committee of the Third Affiliated Hospital of Soochow University approved this study for retrospective analysis (ethics number: 2020-WD-030) and each patient signed an informed consent form before surgery. Inclusion criteria for the study were as follows: age $\geq$8 years; patients with acute renal failure or patients with chronic renal failure who required long-term renal replacement therapy; and patients with unstable hemodynamics, coagulation dysfunction, bleeding tendency, or difficulty in establishing vascular access. Exclusion criteria were as follows: patients on hemodialysis; patients with severe, extensive abdominal adhesion; hernias could not be repaired by surgery; patients with a body mass index (BMI) $>35\,kg/m^2$; and patients with severe mental disorders without appropriate accompanying management. The selection process of patients is shown in Figure 1.

We recorded general information, medical history, laboratory indices, catheterization methods, and the catheterization operation time. We also recorded complications within 1 month (early) and complications at 1 to 6 months (mid-term) after catheterization, including abdominal infection and catheter-related complications (e.g., catheter migration, pericatheter leaks, catheter blockage, and tunnel infection).[6,7,16]

Ultrasonic instruments and diagnostic criteria

The thickness of the subcutaneous adipose layer and muscular layer of the abdominal wall, the position of the iliac artery in the

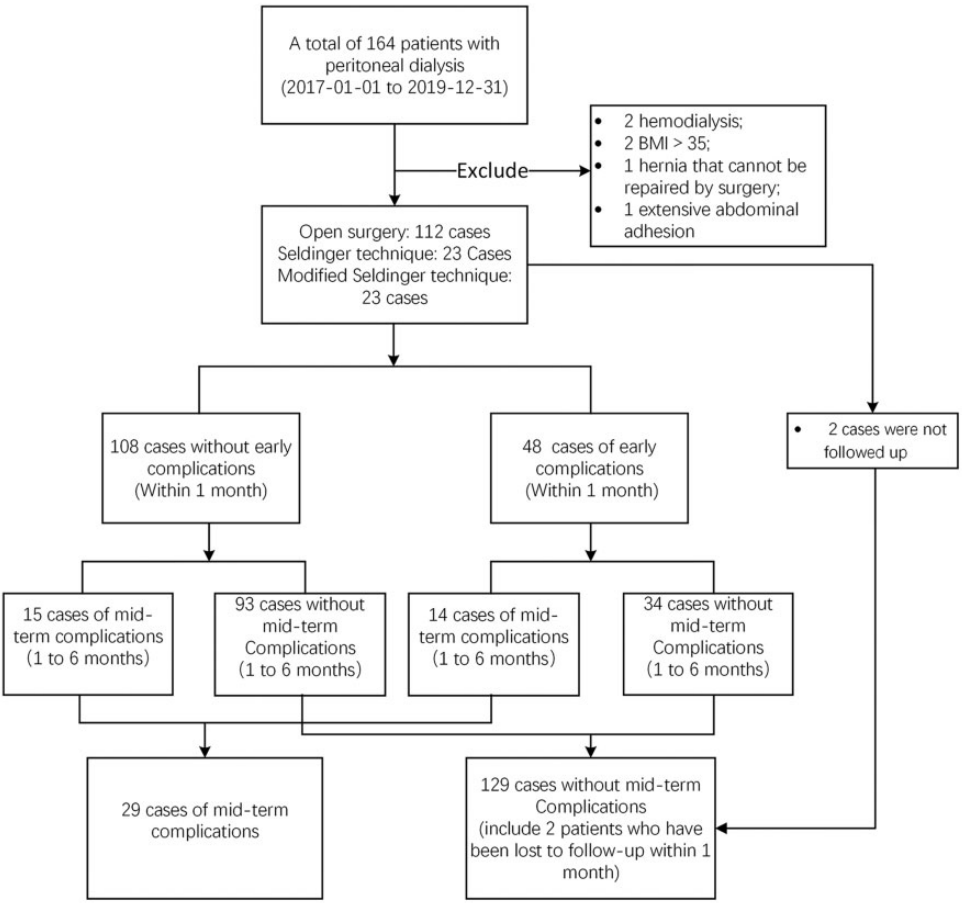

Figure 1. Flow chart of patient selection.
BMI, body mass index.

abdominal cavity, the diameter of blood vessels in subcutaneous tissues, and the distance of visceral movement relative to abdominal wall movement were measured using an ultrasonic diagnostic instrument (Mindray M8 Super; Mindray, Shenzhen, China) equipped with linear array probe (frequency of 4–12 MHz).

Catheter insertion for peritoneal dialysis

The procedure of catheterization in traditional open surgery was as follows. A 3- to 5-cm incision was made on the skin and subcutaneous tissue under local infiltration anesthesia. The anterior sheath of the rectus abdominis was cut longitudinally, and the rectus abdominis was bluntly dissociated to expose the posterior sheath of the rectus abdominis. A small incision was cut in the posterior sheath, and a peritoneal dialysis catheter was inserted into the recto-uterine pouch inside the abdominal cavity under the guidance of a guidewire.[17,18] The Seldinger technique involved use of a Tenckhoff trocar, guidewire, and sheath system to insert the catheter into the abdominal cavity without actual visualization, and the polyester sheath was placed only outside the abdominal muscle tissue.[7] The modified Seldinger technique was performed as follows. Under ultrasound guidance, a Veress needle entered the abdominal cavity from the anterior sheath of the rectus abdominis. Normal saline was injected to ensure that there was no obstruction. A guidewire was placed in the peritoneal fluid above the bladder. The Veress needle was removed, and a dilator was placed along the guidewire to dilate the anterior sheath of the rectus abdominis until it penetrated the peritoneum. Normal saline was injected again to ensure a smooth flow. An avulsion sheath with a core was inserted along the guidewire, and a peritoneal dialysis catheter was placed along the avulsion sheath. After the peritoneal dialysis catheter was in place, the outer segment of the catheter was fixed, the guide wire was withdrawn, and the avulsion sheath was carefully torn off. Peritoneal fluid drainage was unobstructed.[19–21]

Statistical analysis

Measurement data with a normal distribution are expressed as mean $\pm$ standard deviation. Non-normally distributed data are expressed as the 50th percentile (25th, 75th percentiles) and categorical variables are expressed as frequency (%). When appropriate, the independent sample t-test or Mann–Whitney U nonparametric test was used to compare continuous variables. Pearson's chi-square test and Fisher's exact test were used to compare categorical variables.

Multivariate logistic regression analysis was performed to establish a prediction model for complications. The optimal model parameters were selected on the basis of the minimum Akaike's information criterion. The receiver operating characteristic (ROC) curve of the model was generated. The nonparametric repeated sampling method (bootstrap sampling times = 500) as recommended by the Transparent Reporting of a multivariable prediction model for Individual Prognosis Or Diagnosis statement[22] was used to validate the model internally and calculate the 95% confidence interval (CI) of the area under the curve (AUC). $P < 0.05$ was considered statistically significant. All analyses were performed using R software (version 3.4.3, http://www.R-project.org).

Results

Comparison of general data of the patients

A total of 158 patients were enrolled in the study, including 90 men and 68 women, with a mean age of 46.8 ± 15.4 years (range: 8–84 years). The general data of the enrolled patients are shown in Table 1. The catheterization method included open surgery catheterization, the Seldinger technique, and the modified Seldinger technique. The mean operation time for catheterization was 83.6 ± 30.5 minutes. Complications occurred in 48 (30.8%) patients within 1 month, which were mostly catheter-related complications, and abdominal infection only occurred in 5 (3.2%) patients. There were two patients with both abdominal infection and catheter-related complications. Mid-term complications comprised mainly abdominal infection and catheter migration.

Table 1. General data of the patients.

Catheterization method	Total
Number	158
Age (years)	46.8 ± 15.4
Sex	
Female	68 (43.0)
Male	90 (57.0)
BMI (kg/m^2)	22.1 ± 3.3
Systolic blood pressure (mmHg)	157.5 ± 25.2
Diastolic blood pressure (mmHg)	91.1 ± 16.1
Diabetes mellitus	22 (13.9)
Hypertension	143 (90.5)
Glomerulonephritis	107 (67.7)
Ischemic heart disease	17 (10.8)
History of abdominal and pelvic surgery	32 (20.3)
Catheterization method	
Open surgery	112 (70.9)
Seldinger technique	23 (14.6)
Modified Seldinger technique	23 (14.6)
Duration of the catheterization operation (minutes)	83.6 ± 30.5
Early complications postoperatively	48 (30.8)
Abdominal infection	5 (3.2)
Catheter-related complications	45 (28.8)
Catheter migration	41 (26.3)
Pericatheter leaks	6 (3.8)
Catheter blockage	4 (2.6)
Tunnel infection	3 (1.9)
Mid-term complications postoperatively	29 (18.4)
Abdominal infection	12 (7.6)
Catheter migration	9 (5.7)
Pleural fistula	3 (1.9)
Hernia	3 (1.9)
Catheter blockage	2 (1.3)

Data are mean ± standard deviation or n (%).
BMI, body mass index.

Prediction model for early complications

The patients were divided into two groups on the basis of occurrence of early complications (108 patients with no complications vs. 48 with complications). General data of these patients are shown in Table 2. Patients with early complications had a significantly higher systolic blood pressure ($P = 0.047$), a higher incidence of diabetes mellitus ($P = 0.021$), and a higher rate of the Seldinger technique, but a lower rate of the modified Seldinger technique ($P = 0.034$). Other possible early complication-related indices included older age, lower albumin level, and a shorter catheterization time (all $P < 0.10$). Additionally, we found that patients with early complications had a significantly higher proportion of mid-term complications ($P = 0.024$).

Multivariate logistic regression analysis was performed to establish the prediction model for short-term complications. The presence of early complications was used as the dependent variable, and the patients' characteristics, including age, systolic blood pressure, diabetes mellitus, albumin, catheterization time, and catheterization method, were used as independent variables. The prediction model for early complications was constructed as follows: logit (P) = −4.08581 + 0.01864 × systolic blood pressure + 1.52147 × (diabetes mellitus = yes) + 0.92870 × (catheterization method = Seldinger) − 1.10598 × (catheterization method = modified Seldinger) (where P was the probability of early complications).

Table 2. Comparison of the two groups with or without early complications.

Early complications*	No	Yes	*P* value
Number	108	48	
Age (years)	45.2 ± 15.1	50.0 ± 15.8	0.076
Sex			0.467
Female	45 (41.7)	23 (47.9)	
Male	63 (58.3)	25 (52.1)	
BMI (kg/m^2)	22.0 ± 3.1	22.2 ± 3.6	0.727
Systolic blood pressure (mmHg)	155.3 ± 24.1	163.8 ± 26.2	0.047
Diastolic blood pressure (mmHg)	90.8 ± 15.9	92.5 ± 16.4	0.536
Diabetes mellitus	10 (9.3)	11 (22.9)	0.021
Hypertension	96 (88.9)	46 (95.8)	0.161
Glomerulonephritis	78 (72.2)	29 (60.4)	0.143
Ischemic heart disease	13 (12.0)	4 (8.3)	0.493
History of abdominal and pelvic surgery	25 (23.1)	7 (14.6)	0.221
Laboratory indices			
Hemoglobin (g/L)	83.3 ± 14.6	81.1 ± 15.6	0.400
Platelet count ($\times$ 10^9/L)	173.5 ± 57.2	164.2 ± 61.1	0.363
Lymphocyte count ($\times$ 10^9/L)	1.3 ± 0.5	1.2 ± 0.4	0.419
Albumin (g/L)	35.1 ± 4.1	33.8 ± 4.4	0.074
Urea nitrogen (mmol/L)	29.6 ± 9.6	32.0 ± 11.4	0.175
Creatinine (μmol/L)	852.7 ± 288.6	906.4 ± 271.6	0.277
Cholesterol (mmol/L)	4.3 ± 1.3	4.3 ± 1.1	0.965
Triglycerides (mmol/L)	1.7 ± 1.2	1.6 ± 0.8	0.639
Blood potassium (mmol/L)	4.6 ± 0.7	4.6 ± 0.7	0.924
Blood calcium (mmol/L)	2.1 ± 0.3	2.1 ± 0.3	0.557
Duration of the catheterization operation (minutes)	86.4 ± 28.3	77.2 ± 34.7	0.084
Catheterization method			0.034
Open surgery	79 (73.1)	32 (66.7)	
Seldinger technique	11 (10.2)	12 (25.0)	
Modified Seldinger technique	18 (16.7)	4 (8.3)	
Mid-term complications	15 (13.9)	14 (29.2)	0.024

Data are mean ± standard deviation or n (%).
*Lost to follow-up: two cases.
BMI, body mass index.

A nomogram and ROC curve of the prediction model for early complications were further generated (Figure 2a, b). The AUC of the model was 0.697 (95% CI: 0.609–0.785). The sensitivity was 0.750, the specificity was 0.589, the accuracy was 0.639, the positive likelihood ratio was 1.824, and the negative likelihood ratio was 0.425. For the nomogram (Figure 2a), in patients with early complications, we first calculated the points corresponding to systolic blood pressure, diabetes, and the catheterization method. We then added the scores to obtain the total score and used the nomogram to assess the risk of early complications based on the total points. An example of assessment with this nomogram is as follows. In a patient with diabetes (60 points) with a systolic blood pressure of 160 mmHg (40 points) who undergoes catheter insertion for peritoneal dialysis through open surgery (50 points), with a total score of

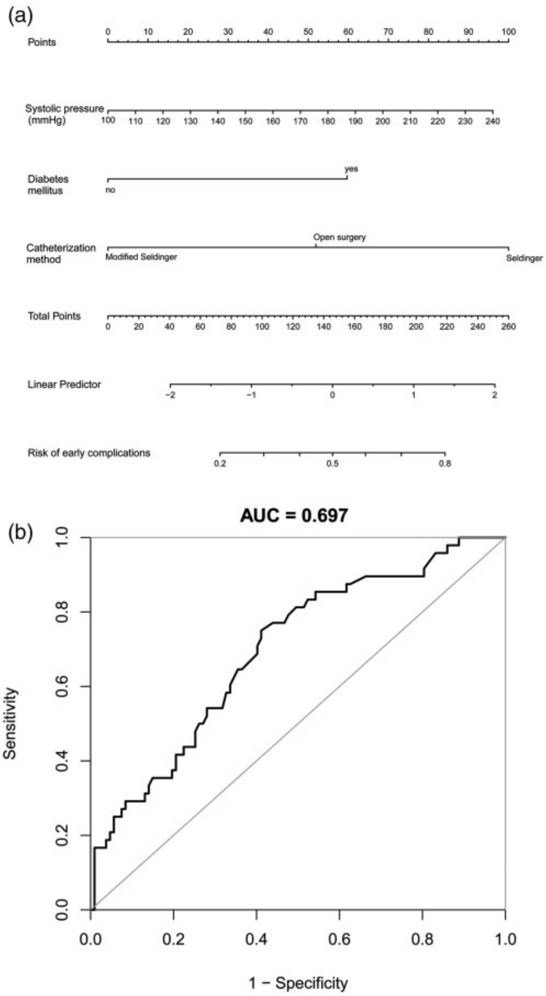

Figure 2. (a) Nomogram of the prediction model for early complications. (b) Receiver operating characteristic curve of the nomogram used to predict early complications after peritoneal dialysis.
AUC, area under the curve.

150 points, the risk of early complications is 54%. The likelihood of early complications increases as the risk value increases.

Prediction model for mid-term complications

The patients were divided into two groups on the basis of whether there were mid-term complications (129 patients without complications vs. 29 patients with complications). Comparison between these two groups is shown in Table 3. BMI and platelet count were significantly lower in patients with mid-term complications than in those without mid-term complications ($P = 0.019$ and 0.038, respectively). Other possible mid-term complication-related indices included a lower lymphocyte count and creatinine levels (both $P < 0.10$). We also

Table 3. Comparison of the two groups of patients with or without mid-term complications.

Mid-term complications	No	Yes	*P* value
N	129	29	
Age (years)	46.6 ± 15.2	47.6 ± 16.4	0.756
Sex			0.842
Female	56 (43.4)	12 (41.4)	
Male	73 (56.6)	17 (58.6)	
BMI (kg/m^2)	22.3 ± 3.3	21.1 ± 3.1	0.019
Systolic pressure (mmHg)	158.8 ± 25.7	151.9 ± 22.7	0.186
Diastolic pressure (mmHg)	91.6 ± 17.0	89.0 ± 11.1	0.438
Diabetes mellitus	19 (14.7)	3 (10.3)	0.538
Hypertension	115 (89.1)	28 (96.6)	0.219
Glomerulonephritis	86 (66.7)	21 (72.4)	0.550
Ischemic heart disease	16 (12.4)	1 (3.4)	0.160
History of abdominal and pelvic surgery	28 (21.7)	4 (13.8)	0.338
Laboratory indices			
Hemoglobin (g/L)	83.2 ± 14.9	81.2 ± 14.8	0.509
Platelet count ($\times$ 10^9/L)	174.8 ± 58.2	153.1 ± 55.3	0.038
Lymphocyte count ($\times$ 10^9/L)	1.3 ± 0.5	1.1 ± 0.4	0.053
Albumin (g/L)	34.5 ± 4.4	34.9 ± 4.2	0.637
Urea nitrogen (mmol/L)	29.8 ± 10.2	32.0 ± 10.5	0.313
Creatinine (μmol/L)	884.1 ± 295.5	783.2 ± 209.0	0.084
Cholesterol (mmol/L)	4.3 ± 1.2	4.2 ± 1.1	0.769
Triglycerides (mmol/L)	1.7 ± 1.0	1.6 ± 1.5	0.745
Blood potassium (mmol/L)	4.6 ± 0.7	4.6 ± 0.7	0.833
Blood calcium (mmol/L)	2.1 ± 0.3	2.1 ± 0.4	0.778
Duration of the catheterization operation (minutes)	83.7 ± 29.9	82.9 ± 34.0	0.902
Catheterization method			0.406
Open surgery	89 (69.0)	23 (79.3)	
Seldinger technique	19 (14.7)	4 (13.8)	
Modified Seldinger technique	21 (16.3)	2 (6.9)	
Early complications	34 (26.8)	14 (48.3)	0.024

Data are mean ± standard deviation or n (%).
BMI, body mass index.

found that patients with mid-term complications had a significantly higher rate of early complications ($P = 0.024$).

Multivariate logistic regression analysis was further carried out to establish the prediction model for mid-term complications. The presence of mid-term complications was the dependent variable, and patients' characteristics, such as BMI, platelet count, lymphocyte count, creatinine levels, and early complications, were independent variables. The prediction model for early complications was constructed as follows: $\text{logit}\ (P) = 6.17128 - 0.20952 \times \text{BMI} - 1.40827 \times \text{lymphocyte count} - 0.00257 \times \text{creatinine} + 1.28672 \times (\text{early complications} = \text{yes})$.

A nomogram and ROC curve of the prediction model for mid-term complications was generated (Figure 3a, b). The AUC of the curve was 0.730 (95% CI: 0.622–0.839). The model's sensitivity was 0.607, the specificity was 0.765, the accuracy was 0.765, the positive likelihood ratio was 3.036, and the negative likelihood ratio was 0.491. For the nomogram, (Figure 3a), the risk

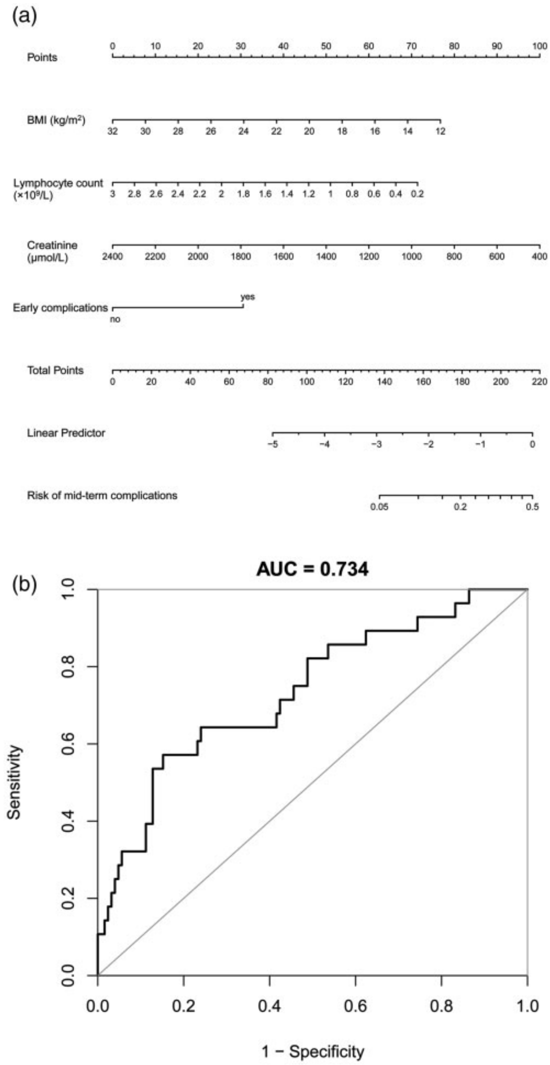

Figure 3. (a) Nomogram of the prediction model for mid-term complications. (b) Receiver operating characteristic curve of the nomogram used to predict mid-term complications after peritoneal dialysis AUC, area under the curve.

assessment methods used for mid-term complications were as follows. We first calculated the points corresponding to BMI, lymphocyte count, creatinine levels, and with or without early complications. We then added the scores to obtain the total score and used the nomogram to assess the risk of mid-term complications based on the total points. An example of assessment with this nomogram is as follows. In a patient with a BMI of 20 kg/m^2 (50 points), a lymphocyte count of 0.6×10^9/L (75 points), a creatinine level of 1400 μmol/L (50 points), and without early complications (0 points), with a total score of 170, the risk of mid-term complications is 17%.

The likelihood of mid-term complications increases as the risk value increases.

Discussion

Complications of peritoneal dialysis can be divided into early, mid-term, and late complications. Early complications (<30 days) mainly include catheter blockage, leakage, catheter migration, early peritonitis, and exit site or tunnel infection.[7,16] Late complications (>6 months) mainly include abdominal infection, catheter migration, dialysis fluid leakage, and hernia.[6] Mid-term complications occur between early and late complications. In this study, we aimed to provide a reference for risk assessment of postoperative complications.

Our study showed that the incidence of early complications was significantly higher than that of mid-term complications (30.8% vs. 18.4%). This finding is consistent with the results of a study on percutaneous and open catheterization complications by Perakis et al.[23] Both studies suggest that the risk of postoperative complications decreases gradually over time. Over time, the incidence of catheter-related complications gradually decreases, and the risk of abdominal infection gradually increases.

We found that catheter migration was the most common early complication. This finding is similar to the results of a retrospective study by Ko et al.[8] who followed 135 patients for 5 years and found that 85.9% of catheter migration occurred in the first 2 weeks after catheter insertion. Crabtree[17] believed that the main reason for catheter migration was that blind penetration might lead to excessive bending of the catheter in the subcutaneous track and incorrect placement of the catheter tip. That author also considered that poor fixation of a catheter to the transmural segment easily leads to catheter movement. Taking into consideration the above-mentioned viewpoints and our results, the reasons for the high rate of catheter migration in early complications can be summarized as follows. First, most patients in this study underwent open surgery for catheterization, which may have led to poor fixation of a catheter to the transmural segment. Second, both open surgery and the Seldinger method in this study involved blind punctures, which may have led to inaccurate positioning of the catheter or excessive bending of the subcutaneous track. Additionally, the catheter might have gradually become straight over time, thus causing catheter migration. Our study showed that the incidence of mid-term abdominal infection was higher than that in the early stage, which is consistent with a study by Park et al.[9] In their study, the incidence of complications of late infection in the open and percutaneous groups was significantly higher than that in the early stage (percutaneous: 2.2% vs. 24.7%; open surgery: 6.4% vs. 12.8%). The incidence of early complications in Park et al.'s[9] study is similar to that in our study, and the higher rate of mid-term complications than this study may be related to the longer follow-up time (1 year).

A comparison of patients with or without early complications showed no significant differences in sex, age, creatinine levels, albumin levels, hemoglobin levels, and other laboratory indices between the two groups. This finding is consistent with that in a study by Hryszko et al.[24] Unlike Hryszko et al.'s study, our study also compared hypertension, diabetes mellitus, and catheterization methods between patients with complications and those without complications. We found that systolic blood pressure and the rate of diabetes mellitus were significantly higher in patients with early complications than in those without early complications. Xia et al.[15] found that diabetic nephropathy was an independent risk factor for technical failure of catheterization. Many studies have also shown that diabetes mellitus is a risk factor for peritonitis after catheterization.[20,21] These results suggest that diabetes mellitus is an independent risk factor for early complications following catheterization.

The catheterization methods in this study included open surgery, the Seldinger method, and the modified Seldinger method, among which open surgery was the main catheterization method. We found that there were significant differences in the incidence of complications among different catheterization methods. The Seldinger technique significantly reduced early complications compared with open surgery, which is consistent with previous studies.[1,11,25] We also found that the modified Seldinger technique significantly reduced early postoperative complications. Therefore, this technique is a relatively safe catheterization method. These results indicate that the catheterization method is an important factor affecting short-term postoperative complications. We included systolic blood pressure, diabetes mellitus, and the catheterization method to construct a prediction model of early complications. Among these three factors, systolic blood pressure and diabetes mellitus were independent risk factors. The prediction model's sensitivity was 0.750, which is of clinical significance for screening of early complications. However, other specific indices need to be used in combination with this prediction model for diagnosing early complications.

When we examined mid-term complications, we found that BMI, platelet count, creatinine levels, and lymphocyte count were lower, and the rate of early complications was higher in patients with mid-term complications than in those without complications. Wu et al.[13] found that a high BMI may be a risk factor for early-onset peritonitis. However, in a study of elderly patients on peritoneal dialysis, Franco et al.[26] showed that an increase in BMI over time was a protective factor, where the risk of death was reduced by approximately 1% for each BMI unit obtained. Additionally, in a study of the effect of BMI on peritonitis, Hwang et al.[27] found that low muscle mass was associated with peritonitis in patients on peritoneal dialysis. Our study found that a low BMI may be a protective factor for mid-term complications, which is consistent with abovementioned results. Creatinine levels can reflect residual renal function to a certain extent. Shemin et al.[28] showed that residual renal function was associated with a reduced mortality rate and improved nutritional status. Unlike the study of Shemin et al.[28], we investigated complications of peritoneal dialysis and found that low creatinine levels were associated with mid-term complications. The possibly of a poor nutritional condition caused reduced creatinine production, leading to increased complications, which is similar to the mechanism of increased complications caused by a low BMI.

Lymphocytes are a class of cell lines with immune recognition function. Lymphocytes are important cellular components of the immune response of the human body. Many studies have shown that the composition and function of T lymphocyte subsets are abnormal in patients with end-stage renal disease.[29] The proportion of peripheral blood lymphocytes decreases at the onset of peritoneal dialysis-associated peritonitis.[30] In our study, we found that a low lymphocyte count was a risk factor for mid-term complications, which may be associated with an increased incidence of peritonitis. Van et al.[31] found a strong association between tunnel exit site infection and subsequent peritonitis from peritoneal dialysis. Data from their study combined with data in our study suggest that the early complications group is more likely to have mid-term complications. We speculate that there is an association between early and mid-term complications. Therefore, we used early complications as an independent variable to construct a predictive model of mid-term complications. When constructing the prediction model for mid-term complications, three independent protective factors of BMI, creatinine levels, and lymphocyte count were included, and early complications were an independent risk factor. This predictive model has certain clinical significance for risk assessment of mid-term complications.

Our study has several limitations. First, this was a retrospective study, and all patients were from one research center, which may have caused selection bias. Second, the sample size of this study was limited. In a future study, the sample size needs to be expanded to establish the prediction models for each catheterization method. Finally, more indices should be included to improve the accuracy of prediction.

Conclusions

In this study, we analyzed the relevant factors of early and mid-term complications after peritoneal dialysis and established prediction models for the risk of complications. Systolic blood pressure, diabetes mellitus, and the catheterization method are the most sensitive predictors of early complications, while BMI, creatinine levels, lymphocyte count, and the presence of early complications can be used as specific predictors of mid-term complications. Establishment of a prediction model of complications has certain clinical significance for risk assessment of early and mid-term complications after insertion of a catheter for peritoneal dialysis and selection of clinical catheterization methods.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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