

## ORIGINAL ARTICLE

# Perioperative application of midline catheter and PICC in patients with gastrointestinal tumors

Fengying Tao<sup>1</sup>, Xiaohe Wang<sup>1</sup>, Jiumei Liu<sup>2</sup>, Jing Li<sup>3</sup>, Fengxiang Sui<sup>4</sup>

<sup>1</sup>Section two of Oncology Department, Qingdao Municipal Hospital, Qingdao 266000, P.R. China; <sup>2</sup>Department of Breast Surgery, Qingdao Central Hospital, Qingdao 266042, P.R. China; <sup>3</sup>Department of Surgery, People's Hospital of Zhangqiu District, Jinan 250200, P.R. China; <sup>4</sup>Department of Respiration, Qingdao Municipal Hospital, Qingdao 266000, P.R. China.

## Summary

**Purpose:** This study aimed to compare the application value of midline catheter and peripherally inserted central catheter (PICC) in patients with gastrointestinal tumors during the perioperative period.

**Methods:** 487 patients with gastrointestinal tumors admitted to Qingdao Municipal Hospital from August 2016 to September 2018 were selected and retrospectively analyzed. 279 patients treated with midline catheters during the treatment were regarded as the study group, and another 208 patients treated with PICC were regarded as the control group. The incidence of perioperative adverse reactions, the cost of daily catheter maintenance and the total cost of catheter indwelling were compared between the two groups. Meanwhile, each patient was investigated for treatment satisfaction at the time of discharge.

**Results:** The total incidence of adverse reactions in the study group was significantly lower than that in the control group ( $p=0.0001$ ). The catheter indwelling duration in the study

group was significantly shorter than that in the control group ( $p<0.001$ ). The 24-h drainage volume in the study group was significantly higher than that in the control group ( $p<0.001$ ). The average cost of daily maintenance and total cost of catheter indwelling in the study group were significantly lower than those in the control group ( $p<0.001$ ). The satisfaction rate in the study group (69.53%) was significantly higher than that in the control group (51.92%) ( $p<0.001$ ). The dissatisfaction rate in the study group (3.23%) was significantly lower than that in the control group (15.38%) ( $p<0.001$ ).

**Conclusion:** Compared with PICC, the perioperative application of midline catheter in patients with gastrointestinal tumors can effectively reduce catheter-related adverse reactions, with higher medical economic benefits and satisfaction rate, and is worthy of clinical promotion and application.

**Key words:** adverse reactions, economic benefits of treatment, gastrointestinal tumor, midline catheter, PICC, satisfaction rate

## Introduction

Gastrointestinal tumors are very common malignancies in the clinic and are included among the deadliest cancers [1]. According to relevant data, the proportion of new patients suffering of this disease in 2018 has exceeded 23.5% [2], and with the rapid population growth in recent years, its incidence is increasing year by year [3]. Moreover, gastrointestinal tumors are usually characterized by acute onset, rapid course of disease and treatment dif-

iculties, which pose a great threat to patients [4]. They have been classified as key research projects in clinical practice, and researchers at home and abroad are committed to continuously and deeply studying their diagnosis and treatment [5,6]. At present, preoperative and postoperative chemotherapy and intravenous nutritional support are usually required in clinical treatment of gastrointestinal tumors, while intravenous infusion of chemotherapy

Corresponding author: Dr. Fengxiang Sui. Department of Respiration, Qingdao Municipal Hospital, No.1 Jiaozhou Rd, Qingdao 266000, P.R. China  
Tel/Fax: +86 0532 82789159, Email: fokez5@163.com  
Received: 06/04/2019, Accepted: 14/05/2019

drugs and nutrient solutions will greatly increase the risk of thrombosis in patients [7]. Therefore, deep vein intubation or peripherally inserted central catheter (PICC) are usually used in establishing intravenous infusion [8]. Many studies around the world have shown that PICC can effectively reduce the probability of catheter-related infections and thrombosis in patients [9], but some studies have pointed out that PICC is more likely to cause blood infection and increase the risk of adverse reactions compared with Hickman catheter [10]. Therefore, finding a safer and more effective catheter placement method is a hotspot in clinical practice.

Peripheral venous midline catheters, also known as midline catheters for short, are the latest infusion tools for peripheral vein catheterization, which not only reduce the pain of patients during venipuncture, but also decrease the stimulation of drugs on blood vessels. Moreover, X-ray localization is not necessary during puncture, thus greatly improving medical benefits [11,12]. Studies at home and abroad have proved that midline catheter can effectively reduce the incidence of exudation and other complications [13,14]. However, as it is generally inserted from vein or cephalic vein with its tip not beyond axillary vein, the use of midline catheter when injecting chemotherapy drugs and nutrient solution is not recommended in clinical practice [15]. Our hospital has achieved remarkable results by increasing the insertion depth of catheters to the subclavian vein and applying it to chemotherapy and nutritional support for patients in the Department of Gastroenterology.

The purpose of this study was to compare the application value of midline catheter and PICC in patients with gastrointestinal tumors during the perioperative period, and to provide reference and guidance for clinical practice.

## Methods

### General information

487 patients with gastrointestinal tumors admitted to the Department of Digestive and Oncology of Qingdao Municipal Hospital from August 2016 to September 2018 were selected and retrospectively analyzed, including 309 males and 178 females, aged 42-73 years, with an average age of  $58.63 \pm 8.84$  years. 279 patients treated with midline catheters during the treatment were regarded as the study group and another 208 patients treated with PICC were regarded as the control group.

### Inclusion and exclusion criteria

*Inclusion criteria:* According with clinical manifestations of gastrointestinal tumors; diagnosed with gastrointestinal tumor by biopsy in our pathology department; indications for surgery; being on treatment in Qingdao

Municipal Hospital after diagnosis; receiving perioperative chemotherapy and intravenous nutrition support during perioperative period; receiving no radiotherapy and chemotherapy within 3 months before surgery; with complete case data; cooperating with the medical staff of our hospital; aged 30-80 years.

*Exclusion criteria:* complicated with other tumors; severe cardio-cerebrovascular diseases; abnormal blood routine tests and coagulation dysfunction; organ failure; hepatic and renal insufficiency; vein defect, infection and thrombosis in anterior cubital region; physical disability; mental disorders; long-term bed rest, unable to take care of themselves; transferring to another hospital.

### Methods

After being evaluated by Qingdao Municipal Hospital's chief digestive surgeon, both groups of patients were required to undergo chemotherapy and intravenous nutrition support during the perioperative period. Catheterization operations were all completed by the nursing staff in Qingdao Municipal Hospital who possessed qualified certificates for PICC catheterization. PICCs were purchased from Bard Company, USA, Groshong NXT CleraVue, with the batch number of RECNO713. The midline catheters were purchased from Health Line International Corporation, USA, with the product code of A120121303. PICC in the control group: patients were placed in supine position, then ultrasound was applied to conduct elbow vascular examination in order to determine the puncture location. The distance from the puncture point to the third rib of the lateral sternoclavicular joint was measured to determine the length of the catheter. Venipuncture was performed after routine disinfection of the puncture point, then the catheter length was recorded. After daily infusion, 10 mL of normal saline was used to flush the catheter, and 3 ml of 10 U/ml heparin saline was used to seal the catheter. Midline catheter in the study group: the puncture location and puncture process were the same as above, but the length of catheter was determined by measuring the distance from the puncture point to the midpoint of the lateral clavicle. After daily infusion, 10 mL of normal saline was used to flush and then to seal the catheter.

### Outcome measures

The incidence rate of adverse reactions in the perioperative period of patients in the two groups such as catheter-related blood stream infection, phlebitis, catheter displacement was evaluated. The incidence rate of adverse reactions equaled to the number of the adverse reactions /total number of cases  $\times 100\%$ . Catheter indwelling duration and drainage volume within 24 h were recorded. Economic benefits of treatment were also recorded: the cost of daily catheter maintenance and the total cost of catheter indwelling of patients in the two groups. Satisfaction survey: referring to the research of Becker-Schiebe et al, the treatment satisfaction survey was carried out on each patient at discharge [16]. The results were divided into satisfaction, needing improvement and dissatisfaction, and the satisfaction rate of patients in the two groups was calculated.

### Statistics

SPSS24.0 statistical software (Beijing Strong-Vinda Information Technology Co., Ltd.) was used to calculate all experimental results, and the Graphpad8 (Shenzhen Soft Head Software Technology Co., Ltd.) was used to draw all figures and double check the results. Counting data were expressed as rates, and chi-square test was used for comparison between groups. The measurement data were all expressed as mean  $\pm$  standard deviation, and *t*-test was used for the comparison between groups.  $P < 0.05$  indicated statistical significance.

## Results

### Comparison of clinical data

There was no significant difference in terms of age, body mass index (BMI), blood routine tests,

gender, tumor type, pathological stage, nodal metastasis, differentiation grade, residence, smoking habits and exercise habits between the two groups ( $p > 0.05$ ), proving the comparability between the two groups (Table 1).

### Comparison of incidence of adverse reactions

In the study group, 2 patients (0.72%) developed phlebitis, 3 (1.08%) developed catheter-related blood stream infection, 2 (0.72%) developed thrombosis and zero catheter obstruction and zero catheter displacement, whereas in the control group, 5 patients (2.40%) developed phlebitis, 6 (2.88%) developed catheter-related blood stream infection, 1 (0.48%) had catheter displacement, 7 (3.37%) developed thrombosis, and zero catheter obstruction. The total incidence of adverse reactions in

**Table 1.** Comparison of clinical data

	Study group (n=279)	Control group (n=208)	<i>t</i> or $\chi^2$	<i>p</i>
Age (years), mean $\pm$ SD	59.17 $\pm$ 9.07	58.62 $\pm$ 10.55	0.617	0.538
BMI (kg/m <sup>2</sup> ), mean $\pm$ SD	20.59 $\pm$ 6.41	20.87 $\pm$ 7.05	0.457	0.648
White blood cells ( $\times 10^9/L$ ), mean $\pm$ SD	4.05 $\pm$ 1.04	4.11 $\pm$ 0.95	0.653	0.514
Red blood cells ( $\times 10^{12}/L$ ), mean $\pm$ SD	4.84 $\pm$ 1.58	4.92 $\pm$ 1.83	0.516	0.606
Platelets ( $\times 10^9/L$ ), mean $\pm$ SD	218.64 $\pm$ 42.66	221.63 $\pm$ 45.07	0.747	0.456
Gender, n (%)			0.034	0.853
Male	178 (63.80)	131 (62.98)		
Female	101 (36.20)	77 (37.02)		
Tumor type, n (%)			2.220	0.330
Gastric cancer	117 (41.94)	95 (45.67)		
Colorectal cancer	94 (33.69)	74 (35.58)		
Esophageal cancer	68 (24.37)	39 (18.75)		
Pathological stage, n (%)			0.503	0.478
I-II	92 (32.97)	75 (36.06)		
III-IV	187 (67.03)	133 (63.94)		
Lymph node, n (%)			0.246	0.620
Yes	42 (15.05)	28 (13.46)		
No	237 (84.95)	180 (86.54)		
Grade of differentiation, n (%)			1.401	0.496
High	53 (19.00)	31 (14.90)		
Moderate	164 (58.78)	128 (61.54)		
Poor	62 (22.22)	49 (23.56)		
Residence, n (%)			0.274	0.601
City	194 (69.53)	140 (67.31)		
Countryside	85 (30.47)	68 (32.69)		
Smoking, n (%)			0.377	0.539
Yes	164 (58.78)	128 (61.54)		
No	115 (41.22)	80 (38.46)		
Exercise, n (%)			1.254	0.263
Yes	64 (22.94)	39 (18.75)		
No	215 (77.06)	169 (81.25)		

the study group was 2.51%, significantly lower than that in the control group (9.13%) ( $p=0.0001$ ) (Table 2).

#### Comparison of catheter indwelling duration and drainage volume within 24 hours

The mean indwelling duration of catheter in the study group was  $4.16 \pm 1.12$  days, significantly shorter than that in the control group ( $6.27 \pm 2.18$  days,  $p < 0.001$ ). The mean 24-h drainage volume in the study group was  $472.62 \pm 61.53$  mL, significantly higher than that in the control group ( $309.68 \pm 40.57$ ,  $p < 0.001$ ) (Figures 1 and 2).

#### Comparison of therapeutic economic benefits

The mean daily maintenance cost in the study group ( $127.62 \pm 12.63$  yuan) was significantly lower than that in the control group ( $178.26 \pm 15.63$  yuan,  $p < 0.001$ ). The mean total cost of catheter indwelling in the study group was  $972.86 \pm 40.57$  yuan which was also significantly lower than that in the control group ( $1418.62 \pm 60.84$  yuan,  $p < 0.001$ ) (Figures 3 and 4).

#### Comparison of treatment satisfaction rate

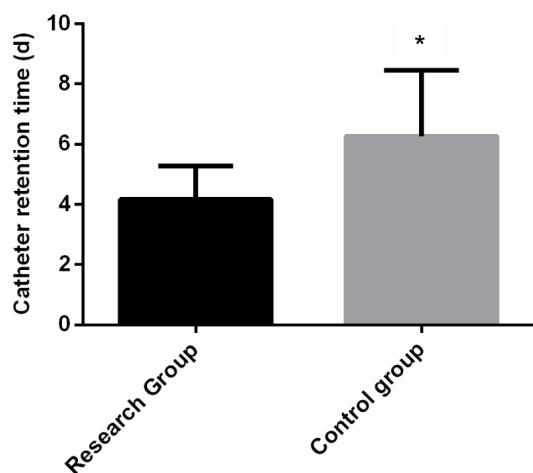
There was no significant difference between the two groups in patients assessed as needing improvement ( $p > 0.05$ ). The satisfaction rate in the study group (69.53%) was significantly higher than that in the control group (51.92%,  $p < 0.001$ ). The dissatisfaction rate in the study group was 3.23%, significantly lower than that in the control group (15.38%,  $p < 0.001$ ) (Table 3).

## Discussion

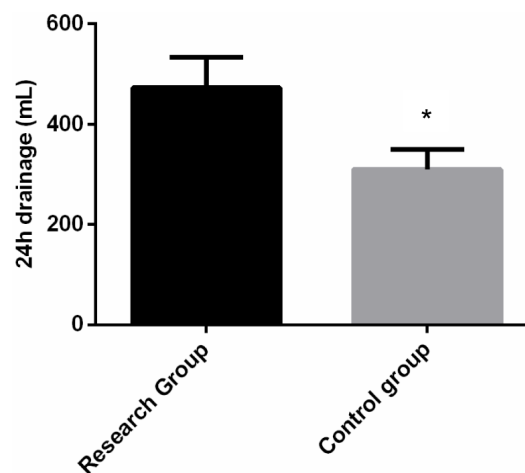
Intravenous infusion and intravenous nutrition support are very common in clinical nursing. At present, there are many methods of intravenous infusion treatment, including midline catheter, PICC, tunnel catheter, embedded infusion port, etc. [17]. However, patients with gastrointestinal tumors are often accompanied by low nutrition, decreased motor function and poor vascular elasticity, so repeated common vascular puncture is not conducive to the treatment [18]. Therefore, indwelling catheter is the most common intravenous infu-

**Table 2.** Comparison of incidence of adverse reactions

	Study group (n=279) n (%)	Control group (n=208) n (%)	$\chi^2$	p
Phlebitis	2 (0.72)	5 (2.40)		
Catheter-related blood stream infection	3 (1.08)	6 (2.88)		
Catheter obstruction	0 (0.00)	0 (0.00)		
Catheter displacement	0 (0.00)	1 (0.48)		
Thrombosis	2 (0.72)	7 (3.37)		
Total incidence (%)	2.51	9.13	10.352	0.001

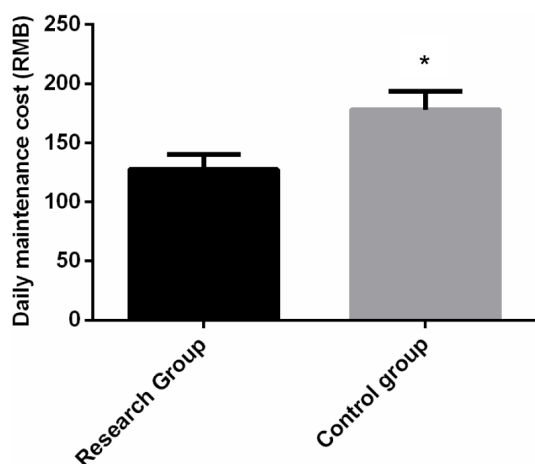


**Figure 1.** Comparison of catheter indwelling duration. The indwelling duration of catheter in the study group was significantly shorter than that in the control group (\* $p < 0.001$ ).

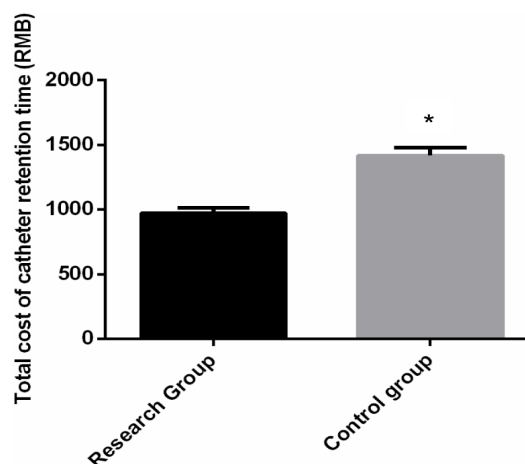


**Figure 2.** Comparison of drainage volume within 24 hours. The 24-h drainage volume in the study group was significantly higher than that in the control group (\* $p < 0.001$ ).





**Figure 3.** Comparison of average daily maintenance cost. The average daily maintenance cost in the study group was significantly lower than that in the control group (\* $p < 0.001$ ).



**Figure 4.** Comparison of total cost of catheter indwelling. The total cost of catheter indwelling in the study group was significantly lower than that in the control group (\* $p < 0.001$ ).

**Table 3.** Comparison of treatment satisfaction rate between two groups

	Study group (n=279) n (%)	Control group (n=208) n (%)	$\chi^2$	<i>p</i>
Satisfaction	196 (70.25)	108 (51.92)	15.693	<0.001
Needing improvement	74 (26.52)	68 (32.69)	2.195	0.138
Dissatisfaction	9 (3.23)	32 (15.38)	22.852	<0.001

sion tool in patients with gastrointestinal tumors. PICC is a technique that uses a catheter to puncture the peripheral vein and then insert into the great vein near the heart, which has been widely used in clinical practice, with high success rate and high application value [19]. PICC can not only reduce the stimulation and injury of chemotherapy drugs to blood vessels, but also decrease the occurrence rate of secondary injury and infection in the treatment process due to long indwelling duration. Currently, it is most commonly used in cancer patients [20]. However, as a new vein indwelling tool, the midline catheter is mainly punctured from brachiocephalic vein, basilic vein or median cubital vein to great vein, with a indwelling duration reaching 1-7 weeks [21]. Midline catheter has the same value as PICC for intravenous infusion, and some studies have even pointed out that the application of midline catheter is more valuable than PICC in the treatment of pediatric diseases [22]. However, due to the fact that the research on the application of midline catheters in China has not yet been popularized, the exact analysis of their effects is still controversial. Therefore, through strict inclusion and exclusion criteria, advanced statistical software and long-term sample collection, this experiment compared the application value of midline catheter and PICC in gastrointestinal tumors, provid-

ing a new direction for future clinical selection of treatments.

Results of this experiment showed that the incidence of adverse reactions in the study group treated with midline catheters was significantly lower than that in the control group with PICC, which is consistent with the results of Anderson et al [22] using midline catheters in the treatment of pediatric diseases. Therefore, the midline catheters are better than PICC in reducing the incidence rate of adverse reactions of gastrointestinal patients during the perioperative period. The reason for the difference is attributed to the different placement methods between the midline catheter and PICC. Puncture can be performed under direct vision with midline catheter and PICC, which can effectively avoid pneumothorax, hemothorax and other complications caused by blind puncture [23]. However, cancer patients are highly likely to have blood hypercoagulability, resulting in a high risk of thrombosis [24], while blood cell attachment in subclavian veins is significantly lower compared with other parts because of the large quantity and speedy blood flow [25], which also greatly reduces the probability of venous thrombosis caused by midline catheters. The midline catheter placement is quite away from the heart and does not require X-ray fluoroscopy during the perioperative

period, so it is safer and has no radiation in patients. However, there are many factors affecting the occurrence of venous thrombosis, thus the exact mechanism needs to be further confirmed. This study showed that the indwelling duration of catheter in the study group was significantly shorter than that in the control group, while the drainage volume within 24 h was significantly higher than that in the control group, suggesting that the effects of midline catheter on drainage and shortening indwelling duration were significantly higher than that of PICC in patients with gastrointestinal tumors during the perioperative period. This study also found that the economic benefits in the study group were significantly better than those in the control group, which also suggests that the use of midline catheter to treat gastrointestinal tumors costs less and reduces the financial burden of patients. This is due to the fact that the midline catheter is located in the axillary vein and does not need to use X-ray for tip location after puncture, and the sealing can be accomplished with normal saline without additional expenses. In addition, the survey results demonstrated that the treatment satisfaction rate in the study group was significantly higher than that in the control group, suggesting that the popularization of midline catheters in patients with gastrointestinal tumors is feasible, and the experience is better than that of PICC. Midline catheter reduces the pressure of nursing staff on puncture and also effectively adjusts their working efficiency, also relieving the pain of patients. Moreover, the flow rate of the drug infused is higher than that of the blood in superficial vein of the

upper arm, which effectively dilutes the side effects of the drug, reduces the stimulation to the vascular endothelium, and thus reduces the incidence rate of adverse reactions [26]. Moreover, compared with PICC, its more affordable medical expenses produce less pressure on patients and their families.

This study compared the application value of midline catheter and PICC in gastrointestinal tumors. However, due to the limited experimental conditions, our study presents some limitations. Firstly, there was a lack of specific comparison with more kinds of infusion tools. Secondly, the exact impact of midline catheter on gastrointestinal tumor patients still remains unclear, so further experimental analysis is still needed to verify our hypothesis. Thirdly, the tumors studied in this study were mainly gastric cancer, colorectal cancer and esophageal cancer, so it is impossible to analyze in detail the effect of midline catheters on each tumor. Therefore, we will expand the sample size of the research object and further explore the application of midline catheters to obtain the best experimental results.

To sum up, compared with PICC, the perioperative application of midline catheter in patients with gastrointestinal tumors can effectively reduce catheter-related adverse reactions, with higher medical economic benefits and satisfaction rate, and is worthy of clinical promotion and application.

### Conflict of interests

The authors declare no conflict of interests.

### References

1. Marusawa H, Jenkins BJ. Inflammation and gastrointestinal cancer: an overview. *Cancer Lett* 2014;345:153-6.
2. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2018;68:394-424.
3. Pourhoseingholi MA, Vahedi M, Baghestani AR. Burden of gastrointestinal cancer in Asia; an overview. *Gastroenterol Hepatol Bed Bench* 2015;8:19-27.
4. Peery AF, Dellon ES, Lund J et al. Burden of gastrointestinal disease in the United States: 2012 update. *Gastroenterology* 2012;143:1179-87.e1173.
5. Li T, Meng XL, Yang WQ. Long Noncoding RNA PVT1 Acts as a "Sponge" to Inhibit microRNA-152 in Gastric Cancer Cells. *Dig Dis Sci* 2017;62:3021-8.
6. Shao YG, Ning K, Li F. Group II p21-activated kinases as therapeutic targets in gastrointestinal cancer. *World J Gastroenterol* 2016;22:1224-35.
7. Tuzovic M, Herrmann J, Iliescu C, Marmagkiolis K, Ziaeeian B, Yang EH. Arterial Thrombosis in Patients with Cancer. *Curr Treat Options Cardiovasc Med* 2018;20:40.
8. Nolan ME, Yadav H, Cawcutt KA, Cartin-Ceba R. Complication rates among peripherally inserted central venous catheters and centrally inserted central catheters in the medical intensive care unit. *J Crit Care* 2016;31:238-42.
9. Grau D, Clarivet B, Lotthe A, Bommart S, Parer S. Complications with peripherally inserted central catheters (PICCs) used in hospitalized patients and outpatients: a prospective cohort study. *Antimicrob Resist Infect Contro* 2017;16:18.

10. Christensen LD, Holst M, Bech LF et al. Comparison of complications associated with peripherally inserted central catheters and Hickman catheters in patients with intestinal failure receiving home parenteral nutrition. Six-year follow up study. *Clin Nutr* 2016;35:912-7.
11. Woller SC, Stevens SM, Evans RS. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC) initiative: A summary and review of peripherally inserted central catheter and venous catheter appropriate use. *J Hosp Med* 2016;11:306-10.
12. Nuckols TK, Keeler E, Morton SC et al. Economic Evaluation of Quality Improvement Interventions for Bloodstream Infections Related to Central Catheters: A Systematic Review. *JAMA Intern Med* 2016;176:1843-54.
13. Mushtaq A, Navalkele B, Kaur M et al. Comparison of complications in midlines versus central venous catheters: Are midlines safer than central venous lines? *Am J Infect Control* 2018;46:788-92.
14. Caparas JV, Hu JP. Safe administration of vancomycin through a novel midline catheter: a randomized, prospective clinical trial. *J Vasc Access* 2014;15:251-6.
15. Johnston AJ, Holder A, Bishop SM, See TC, Streater CT. Evaluation of the Sherlock 3CG Tip Confirmation System on peripherally inserted central catheter malposition rates. *Anaesthesia* 2014;69:1322-30.
16. Becker-Schiebe M, Pinkert U, Ahmad T, Schafer C, Hoffmann W, Franz H. Predictors of overall satisfaction of cancer patients undergoing radiation therapy. *Patient Prefer Adherence* 2015;9:1381-8.
17. Xu T, Kingsley L, DiNucci S et al. Safety and utilization of peripherally inserted central catheters versus midline catheters at a large academic medical center. *Am J Infect Control* 2016;44:1458-61.
18. Zhang L, Lu Y, Fang Y. Nutritional status and related factors of patients with advanced gastrointestinal cancer. *Br J Nutr* 2014;111:1239-44.
19. Harrold K, Martin A, Scarlett C. Proactive PICC placement: evaluating the patient experience. *Br J Nurs* 2016;25:S4-14.
20. Kabsy Y, Baudin G, Vinti H et al. Peripherally inserted central catheters (PICC) in onco-hematology. PICC line in onco-hematology. *Bull Cancer* 2010;97:1067-71.
21. Adams DZ, Little A, Vinsant C, Khandelwal S. The Midline Catheter: A Clinical Review. *J Emerg Med* 2016;51:252-8.
22. Day DL, Conde F. Evaluation of Dwell Time for Peripheral Intravenous Catheters Started in the Field for Geriatric Blunt Trauma Patients. *J Trauma Nurs* 2018;25:165-70.
23. Cotogni P, Pittiruti M. Focus on peripherally inserted central catheters in critically ill patients. *World J Crit Care Med* 2014;3:80-94.
24. Mager R, Daneshmand S, Evans CP et al. Renal cell carcinoma with inferior vena cava involvement: Prognostic effect of tumor thrombus consistency on cancer specific survival. *J Surg Oncol* 2016;114:764-8.
25. Ballard DH, Samra NS, Gifford KM, Roller R, Wolfe BM, Owings JT. Distance of the internal central venous catheter tip from the right atrium is positively correlated with central venous thrombosis. *Emerg Radiol* 2016;23:269-73.
26. Wada M, Kitayama M, Hashimoto H et al. Brief reports: plasma ropivacaine concentrations after ultrasound-guided rectus sheath block in patients undergoing lower abdominal surgery. *Anesth Analg* 2012;114:230-2.