

A Study of Use of “PORT” Catheter in Patients with Cancer: A Single-Center Experience

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ABSTRACT

BACKGROUND: Effective and reliable venous access is one of the cornerstones of modern medical therapy in oncology.

MATERIALS AND METHODS: This is a prospective observational study, which collected data of patients who require “PORT” catheter insertion for any cancer, at a tertiary care oncology hospital in Ahmedabad, Gujarat, India, during a 2-year period.

AIMS AND OBJECTIVES: The main objective of this study was to study the various complications and outcomes related to “PORT” catheters.

RESULTS: “PORT” catheter was inserted in 100 patients and was most commonly used in solid malignancies ($n = 86$, 86%), followed by hematologic malignancies ($n = 14$, 14%). Among the solid malignancies, breast cancer (38, 38%) was the most common underlying disease, whereas among the hematologic malignancies, acute lymphoblastic leukemia (6, 6%) was the most common underlying disease for “PORT” catheter insertion. Chemotherapy was started on the first day of “PORT” catheter in 74% of patients in the “PORT” study group. The various complications developed in the “PORT” study group in the descending order are as follows: 4 patients (4%) developed early infection (≤ 30 days after “PORT” placement), 4 (4%) late infection (≥ 30 days after “PORT” placement), 4 (4%) bloodstream infection, 2 (2%) local skin infection at the “PORT” insertion site, 2 (2%) dislodgment of the “PORT” catheter, 2 (2%) fracture of the “PORT” catheter, and 1 recurrent pleural effusion. One patient (1%) developed thrombosis as the complication of “PORT” catheter insertion.

CONCLUSIONS: The most disturbing aspect of treatment for a patient with cancer is multiple painful venipunctures made for administration of cytotoxic agents, antibiotics, blood products, and nutritional supplements. The focus of this prospective observational research is to study the various underlying diseases for which “PORT” catheter is needed in different solid and hematologic malignancies and the various complications and outcomes in pediatric and adult patients with cancer.

KEYWORDS: Hickman catheter, malignancies, complications, infections

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Introduction

Effective and reliable venous access is one of the cornerstones of modern medical therapy in oncology.²⁷ The management of a patient with cancer demands stable venous access that is used for a wide range of underlying diseases, including chemotherapy, blood product and antibiotic administration, and fluid resuscitation. The use of long-term venous access devices (LTVADs) or central venous catheters (CVCs) can also decrease patient anxiety associated with repeated venipunctures. The number and variety of LTVADs used in oncology practices are as follows:

- Peripherally inserted central catheters (PICC);
- Hickman line (cuffed or uncuffed tunneled) CVCs;
- Subcutaneous implanted “PORT” catheters.¹

Peripherally inserted central catheters, Hickman, and “PORT” devices provide reliable and safe intravenous access to a variety of

underlying diseases in oncology.² Peripherally inserted central catheters, Hickman, and “PORT” devices are frequently used in oncology patients to deliver chemotherapy as well as other intravenous medications, fluids, and total parenteral nutrition.³

The implantable “PORT” consists of a catheter attached to a reservoir that is implanted into a surgically created pocket on the chest wall or upper arm. Some patients require fluoroscopic guidance for “PORT” insertion.²⁵ A needle is inserted through the septum of the “PORT” to access the reservoir.

Advantages include less interference with daily activities, less frequent flushing, and reduced risk of infection. Disadvantages include the need for needle insertion, increased discomfort, and risk of extravasation. These devices are expensive and are more difficult and time-consuming to insert and remove.

Although the initial cost of central venous access port devices (CVAPD) is high, a case-control study comparing



durability and cost of CVAPD and external catheters demonstrated long-term economic benefit for CVAPD for use beyond 6 months due to lower ongoing maintenance costs.⁴ Implanted venous access devices can be inserted either peripherally near the antecubital fossa (Passport) or centrally into the subclavian or jugular vein (CVAPD). Peripheral “PORT” has a lower risk of infection than CVAPD, and their insertion involves a minimal risk of pneumothorax and hemothorax. However, they have a shorter useful lifetime than CVAPD, and there is an increased risk of venous sclerosis following the use of cytotoxic agents, which makes them unsuitable for cancer patients receiving long-term chemotherapy.^{5,27} Increasing age, male gender, and open-ended catheter use were significant risk factors reducing survival of totally implantable venous access devices as determined by univariate and multivariate analyses.²⁸

The intravascular segment of “PORT” catheter is made of similar material to Hickman and Groshong catheters. The thick injection membrane of the system is housed in a titanium or plastic case, which is surgically implanted under the skin’s subcutaneous tissue, usually on the patient’s chest wall or upper arm. It is then accessed with a special noncoring Huber-type needle. This provides a more acceptable cosmetic option and allows the patient to swim or bathe, which are restricted practices with externally exiting catheters. “PORT” kits are expensive, time-consuming to insert, and the accessing needles have a fine bore (6F or 7F) that restricts flows for blood transfusion or venesection. The novelty of this research is that this is the first Indian study with a maximum number of patients with most number of cancer patients from a tertiary oncology unit from the developing countries.

Aims and Objectives

1. To study the various complications and outcomes related to “PORT” catheters;
2. To study the various underlying diseases of “PORT” catheters in different solid and hematologic malignancies in the pediatric and adult patients with cancer attending to the Department of Medical & Pediatric Oncology.

Materials and Methods

This is a prospective observational study, which collected data of patients diagnosed with any cancer, at a tertiary care oncology hospital in Ahmadabad, Gujarat, India, during a 2-year period (August 2013 to August 2015). Patients of all age and sex, presenting to Department of Medical & Pediatric Oncology and hematology at Gujarat Cancer & Research Institute (GCRI), were included.

The data were collected from the Department of Anesthesia, Department of Surgical Oncology, and institutional (GCRI) websites, from patients admitted in the Department of Medical & Pediatric Oncology. Patients were interviewed using a detailed questionnaire regarding their age, sex, clinical symptoms, and

treatment received outside GCRI. A particular note was made of a history of any thromboembolic disease, bleeding disorders, and whether the patient was ever treated for that.

The data were collected for underlying diseases of “PORT” catheter in various malignancies. The data were collected from the patient, for the complications related to “PORT” catheter, directly through clinical symptoms, examination findings, and specific investigations, such as blood culture and differential time to positivity, Doppler of the affected part, and outcomes of treatment.

In our center, “PORT” catheter insertion was performed under anesthesia, in the operation theater.

The study was approved by the Ethics Committee of GCRI, Ahmadabad, Gujarat, India. Written informed consent was obtained from the patients or the parent/guardian for publication of the clinical details in this report.

Inclusion criteria

- All patients with cancer presenting to medical and pediatric oncology and hematology;
- All histopathologically confirmed patients with cancer;
- All the stages and performance status.

Exclusion criteria

- Abnormal coagulation profile (bleeding diathesis);
- Platelet count $<15\,000/\text{mm}^3$;
- Did not consent.

Definitions

Catheter-related infection

Central line-associated bloodstream infection (BSI) refers to a BSI that appears in the presence of a CVC or within 48 hours of removal of a CVC and which cannot be attributed to an infection unrelated to the catheter; it is defined by the National Healthcare Safety Network for the purpose of surveillance of health care-associated infection.

Catheter-related thrombosis

Catheter-associated thrombosis is defined as a mural thrombus extending from the catheter into the lumen of a vessel and leading to partial or total catheter occlusion with or without clinical symptoms.

Results and Observations

In this prospective observational study, patients of all age and sex, presenting to Department of Medical & Pediatric Oncology, were included, with a diagnosis of any cancer, at GCRI, a tertiary care oncology hospital in Ahmadabad, Gujarat, India, during a 2-year period (August 2013 to August 2015). The data were collected for the underlying diseases, complications, and

MALIGNANCIES

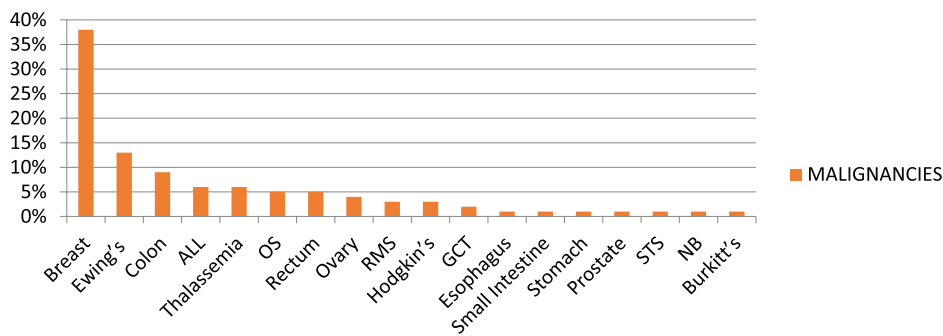


Figure 1. Various underlying diseases of the "PORT" catheter in hematologic and solid malignancy groups. ALL indicates acute lymphoblastic leukemia; GCT, germ cell tumor; NB, neuroblastoma; OS, osteosarcoma; RMS, rhabdomyosarcoma; STS, soft tissue sarcoma.

outcomes of "PORT" catheter in various malignancies, from the patients admitted at the Department of Medical & Pediatric Oncology, bone marrow transplantation unit, surgical oncology, and Department of Anesthesia. Patients were interviewed using a detailed questionnaire regarding their age, sex, clinical symptoms, and treatment received outside GCRI.

Distribution of the study population

A total of 652 patients were enrolled as the study population for the LTVADs study, of which 352 (53.98%) required PICC insertion, 200 (30.67%) required Hickman catheter insertion, and 100 (15.33%) required "PORT" catheter insertion as part of their comprehensive management strategy in our cancer center.

Age and sex distribution of the study group

Of the 100 patients in the "PORT" study group, 17 (17%) were in the less than 14 years age group (pediatric population), 81 were in the adult (14-65 years) age group (81%), and 2 were in the geriatric age group (2%); 41 were men (41%) and 59 were women (59%).

Diagnosis and various underlying diseases of the "PORT" catheter in patients with cancer

In our study group, "PORT" catheter insertion was most commonly used in patients with solid malignancies (n = 86 [86%]), followed by (n = 14 [14%]) hematologic malignancies. Among the solid malignancies, breast cancer (n = 38 [38%]) was the most common underlying disease, whereas among the hematologic malignancies, acute lymphoblastic leukemia (ALL) (n = 6 [6%]) was the most common underlying disease for "PORT" catheter insertion (Figure 1 and Table 1).

Antibiotic prophylaxis

All the 100 patients in the "PORT" study group received prophylactic antibiotics in the form of single-dose ceftriaxone 1 g intravenously, 1 hour before the insertion of "PORT" catheter.

Table 1. Various underlying diseases of the "PORT" catheter in solid and hematologic malignancies.

| SOLID MALIGNANCIES | NO. (%) |
|--------------------------|----------|
| Breast | 38 (38%) |
| Ewing | 13 (13%) |
| Colon | 9 (9%) |
| Rectum | 5 (5%) |
| OS | 5 (5%) |
| Ovary | 4 (4%) |
| RMS | 3 (3%) |
| Hodgkin | 3 (3%) |
| Prostate | 1 (1%) |
| GCT | 2 (2%) |
| Esophagus | 1 (1%) |
| STS | 1 (1%) |
| Small intestine | 1 (1%) |
| NB | 1 (1%) |
| HEMATOLOGIC MALIGNANCIES | NO. (%) |
| ALL | 6 (6%) |
| Thalassemia | 6 (6%) |
| Burkitt | 1 (1%) |
| Stomach | 1 (1%) |

Abbreviations: ALL, acute lymphoblastic leukemia; GCT, germ cell tumor; NB, neuroblastoma; OS, osteosarcoma; RMS, rhabdomyosarcoma; STS, soft tissue sarcoma.

Day of start of chemotherapy

Of the 100 patients in the "PORT" study group, 74 (74%) were started on chemotherapy on the first day of catheter insertion, 12 (12%) on second day of catheter insertion, 6 (6%) on third day of catheter insertion, and 4 (4%) each on fourth and fifth days of catheter insertion (Figure 2).

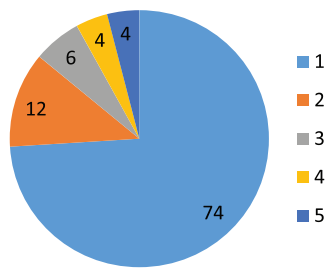


Figure 2. Day of start of chemotherapy in the "PORT" study group.

Table 2. Distribution of cases of infection, catheter displacement, catheter fracture, recurrent pleural effusion, and thrombosis in the "PORT" study group.

| S. NO. | COMPLICATION | NO. (%) |
|--------|----------------------------|----------|
| 1 | Infection | 12 (12%) |
| 2 | Catheter displacement | 2 (2%) |
| 3 | Catheter fracture | 2 (2%) |
| 4 | Recurrent pleural effusion | 1 (1%) |
| 5 | Thrombosis | 1(1%) |

Distribution of infection, catheter displacement, catheter fracture, recurrent pleural effusion, and thrombosis in the "PORT" study group

Of the 100 patients, 4 (4%) developed early infection (≤ 30 days after "PORT" placement) and another 4 (4%) developed late infection (≥ 30 days after "PORT" placement), 4 (4%) developed BSI, and 2 (2%) developed local skin infection at the "PORT" insertion site. Of the 100 patients, 2 (2%) developed displacement of the "PORT" catheter, 2 (2%) developed fracture of the "PORT" catheter, 1 patient developed recurrent pleural effusion because of direct catheter tip in pleural cavity, and 1 (1%) developed thrombosis as the complication of catheter insertion in the "PORT" study group (Table 2).

Discussion

The most disturbing aspect of treatment of a patient with cancer is multiple painful venipunctures made for administration of cytotoxic agents, antibiotics, blood products, and nutritional supplements. To overcome the problems of arteriovenous fistulae, peripherally inserted silicone catheters and implantable "PORTs" have been tried with varying success. The introduction of CVCs in the 1980s significantly improved the quality of life (QOL) of oncology patients.⁶⁻⁹

The focus of this prospective observational research is to study the various underlying diseases of "PORT" catheter in different solid and hematologic malignancies and the various complications and outcomes in pediatric and adult patients with cancer attending the Department of Medical & Pediatric Oncology, over a 24-month period (August 2013 to August 2015), in a tertiary oncocare center situated in Western India.

Following an extensive search of the literature, it became evident that there were very few research studies from the Indian and Asian subcontinents focusing specifically on "PORT" lines within oncology cohorts, and to the best of our knowledge, this may be the largest prospective study in the Indian literature.

In this study, an attempt is made to compare the study results with the previous studies from the published literature, with specific findings of the particular group from our study. Most of the studies in the literature are retrospective in nature, and this study with robust number of patients and data may be helpful for future comparative studies.

This study results reported similar demographics to those of other published studies. Of the studies that reported gender, all studies showed their cohort as having a slight predominance of men over women, and that most were older than 50 years. A study by Kumar et al¹⁰ shows that there is male predominance for the indication of LTVADs.

A study by Patel et al¹¹ shows that the median age for "PORT" catheter insertion is 24 years, but in our study, the median age for "PORT" catheter was 36 years. The discordance may be due to the differences in the selection of the patients.

This study's cohort was positioned in an oncology department; thus, chemotherapy was the primary reason for "PORT" catheter insertion, and this was reflected in the studies by Yap et al³ and Cheong et al.¹² Most of the patients have PICC, Hickman, and "PORT" catheter insertion for intravenous (IV) chemotherapy, antibiotics, pain management, total parenteral nutrition, hydration, apheresis and life support treatments, or IV access.^{3,12-14}

"PORT" catheter was inserted in 100 patients and most commonly used in solid malignancies ($n = 86$ [86%]), followed by hematologic malignancies ($n = 14$ [14%]). Among the solid malignancies, breast cancer (38 [38%]) was the most common underlying disease, whereas among the hematologic malignancies, ALL (6 [6%]) was the most common underlying disease for "PORT" catheter insertion. All the 100 patients in the "PORT" study group received prophylactic antibiotics before the insertion of "PORT" catheter. Chemotherapy was started on the first day of "PORT" catheter in 74% of patients in the "PORT" study group. The various complications in our study as compared with other studies³¹ in the "PORT" study group in descending order are as follows: 4 patients (4%) developed early infection, 4 (4%) developed late infection,^{22,23,26,30} 4 (4%) developed BSI, 2 (2%) developed local skin infection at the "PORT" insertion site, 2 (2%) developed dislodgment of the "PORT" catheter, 2 (2%) developed fracture of the "PORT" catheter, 1 (1%) developed thrombosis,²⁴ and 1 developed recurrent pleural effusion.²⁹

Most of the literature is retrospective in nature, and the largest of this type is the study by Aparna et al in the pediatric population, and our results are comparable with this study and other smaller Indian studies. We compared our results with

Table 3. Comparison of “PORT” study results with the various Indian studies.

| CHARACTER | JAIN ET AL ¹⁵ | ABRAHAM ET AL ¹⁶ | APARNA ET AL ¹⁷ | PANDEY ET AL ¹⁸ | PRESENT STUDY, NO. (%) |
|------------------------------------|--------------------------|-----------------------------|----------------------------|----------------------------|------------------------|
| No. of cases | 25 | 81 | 200 | 9 | 100 |
| Antibiotic prophylaxis | 97% | 100% | 100% | NA | 100 (100%) |
| First day of start of chemotherapy | 77% | 67% | NA | 68% | 74 (74%) |
| Infection ^{22,23,26} | 7% | 10% | 12.5 | 8.70% | 8 (8%) |
| Catheter fracture | NA | 2.4% | 0.5% | 0.6% | 2 (2%) |
| Catheter displacement | NA | 2% | 0.5% | 1.8% | 2 (2%) |
| Thrombosis ²⁴ | 0.4% | 6% | 0.50% | 1.8% | 1 (1%) |
| Median catheter days | 280 | 246 | 270 | NA | 337 |

Table 4. Comparison of “PORT” study results with international studies.

| CHARACTER | MSKCC STUDY ^{20,21} | VARDY ET AL ¹⁹ | PRESENT STUDY, NO. (%) |
|------------------------------------|------------------------------|---------------------------|------------------------|
| No. of cases | 680 | 110 | 100 |
| Antibiotic prophylaxis | 100% | NA | 100% |
| First day of start of chemotherapy | NA | 67% | 74 (74%) |
| Infection | 8% | 4% | 8 (8%) |
| Catheter fracture | NA | 2% | 2 (2%) |
| Catheter displacement | 3% | NA | 2 (2%) |
| Thrombosis | 2% | 2% | 1 (1%) |
| Median catheter days | 361 | 237 | 337 |
| Most common indication | Breast cancer | GIT | Breast cancer |

Abbreviations: MSKCC, Memorial Sloan Kettering Cancer Center; GIT, Gastro Intestinal Tract.

some of the important Indian studies, which are shown in Table 3.

The present “PORT” study results are also comparable with the following 2 international studies: one is the study from Memorial Sloan Kettering Cancer Center on 680 patients between June 1987 and May 1989, and another is a prospective study by Vardy et al¹⁹ on 110 consecutive patients who had insertion of 111 subclavian CVAPD; the “PORT” study results were comparable (Table 4).

Future Perspectives

As this study stands out to be one of the major prospective observational study and most of the data at present in Indian setup are retrospective in nature, this study can be used for future prospective observational studies. It provides suggestions for future medical researchers to incorporate QOL measures, details of different infections, drug sensitivity, and advanced technological methods, such as Groshong catheters with different designs and materials with proper methods of education, to the patient and his or her relative for catheter care.

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Author Contributions

IM conceived and designed the experiment, made critical revisions, and approved the final version. IM and AP analyzed the data and wrote the first draft of the manuscript. IM, AP, MS, AA, HP, and SP contributed to the writing of the manuscript. MS, AA, HP, and SP agree with the manuscript results and conclusions. IM, MS, HP, and SP jointly developed the structure and arguments for the paper. All authors reviewed and approved the final manuscript.

Ethics

Written informed consent was obtained from all the patients for the publication of this original research and accompanying images. The ethics committee of the GCRI approved the study.

REFERENCES

- Schaffer CA, Mangu PB, Wade JC, et al. Central venous catheter care for the patient with cancer: American Society of Clinical Oncology clinical practice guideline. *J Clin Oncol*. 2013;31:1357–1370.
- Chu FS, Cheng VC, Law MW, Tso WK. Efficacy and complications in peripherally inserted central catheter insertion: a study using 4-Fr non-valved catheters and a single infusate. *Australas Radiol*. 2007;51:453–457.
- Yap S, Karapetis C, Lerosse S, Iyer S, Koczwara B. Reducing the risk of peripherally inserted central catheter line complications in the oncology setting. *Eur J Cancer Care (Engl)*. 2006;15:342–347.
- McCready D, Broadwater R, Ross M, Pollock R, Ota D, Balch C. A case-control comparison of durability and cost between implanted reservoir and percutaneous catheters in cancer patients. *J Surg Res*. 1991;51:377–381.
- Salem R, Ward B, Ravikumar TS. A new peripherally implanted subcutaneous permanent central venous access device for patients requiring chemotherapy. *J Clin Oncol*. 1993;11:2181–2185.
- Steckler RM, Martin RG, Speer JF, McCredie KB. Vascular access by means of surgically created arteriovenous fistulas in the chemotherapy of acute leukemia: a preliminary report. *South Med J*. 1974;67:821–822.
- Gyves J, Ensminger W, Neiderhuber J, et al. Totally implanted system for intravenous chemotherapy in patients with cancer. *Am J Med*. 1982;73:841–845.
- Cameron GS. Central venous catheters for children with malignant disease: surgical issues. *J Pediatr Surg*. 1987;22:702–704.
- Iannacci L, Piomelli S. Supportive care for children with cancer. Guidelines of the Children's Cancer Study Group. Use of venous access lines. *Am J Pediatr Hematol Oncol*. 1984;6:277–281.
- Kumar AH, Srinivasan NM, Thakkar JM, Mathew S. A prospective observational study of the outcome of central venous catheterization in 100 patients. *Anesth Essays Res*. 2013;7:71–75.
- Patel PM, Thakkar JM, Patel BM. Long term venous access catheter in cancer patients at GCRI. *Guj Med J*. 2010;65:1.
- Cheong K, Perry D, Karapetis C, Koczwara B. High rate of complications associated with peripherally inserted central venous catheters in patients with solid tumours. *Intern Med J*. 2004;34:234–238.
- Othersen HB Jr, Hebra A, Chessman KH, et al. Central lines in parenteral nutrition. In: Baker RD Jr, Baker SS, Davis AM, eds. *Pediatric Parenteral Nutrition*. New York, NY: Chapman & Hall; 1997;254–271.
- Scott WT, Bergamini MB. Long-term venous access: indications and choice of site and catheter. *Semin Vasc Surg*. 1997;10:130–134.
- Jain SA, Shukla SN, Talati SS, et al. A retrospective study of central venous catheters GCRI experience. *Indian J Med Paediatr Oncol*. 2013;34:238–241.
- Abraham SW, Bassi KK, Giri AK, Pandey KK, Pattanayak M. Totally implantable venous access ports: retrospective review of long-term complications in 81 patients. *Indian J Cancer*. 2012;49:114–118.
- Aparna S, Ramesh S, Appaji L, et al. Complications of chemoport in children with cancer: experience of 54,100 catheter days from a tertiary cancer center of Southern India. *South Asian J Cancer*. 2015;4:143–145.
- Pandey R, Patel AA, Shah SA, et al. Central venous access in the pediatric cancer patient—problems unique to developing countries: 5-year experience at a regional cancer center in Western India. *J Clin Oncol*. 2006;24:9049.
- Vardy J, Engelhardt K, Cox K, et al. Long-term outcome of radiological-guided insertion of implanted central venous access port devices (CVAPD) for the delivery of chemotherapy in cancer patients: institutional experience and review of the literature. *Brit J Cancer*. 2004;91:1045–1049.
- Schwarz RE, Groeger J, Coit DG. Subcutaneously implanted central venous access devices in cancer patients: a prospective analysis. *Cancer*. 1997;79:1635–1640.
- Kock HJ, Pietsch M, Krause U, Wilke H, Eigler FW. Implantable vascular access system: experience in 1500 patients with totally implanted central venous port systems. *World J Surg*. 1998;22:12–16.
- Bertaut A, Cassier P, Rogues AM. Infections associées aux chambres à cathéter implantables, épidémiologie ET prévention: revue de la littérature. *J Anti-Infect*. 2012;14:151–158.
- Shim J, Seo T-S, Song MG, et al. Incidence and risk factors of infectious complications related to implantable venous access ports. *Korean J Radiol*. 2014;15:494–500.
- Noel-Savina E, Quere G, Gouva S, Robinet G, Descourt R. Percutaneous implantable port-related infection and thrombosis: diagnostic and management. *Bull Cancer*. 2011;98:1107–1118.
- Ahn SJ, Kim HC, Chung JW, et al. Ultrasound and fluoroscopy-guided placement of central venous ports via internal jugular vein: retrospective analysis of 1254 port implantations at a single center. *Korean J Radiol*. 2012;13:314–323.
- Dal Molin A, Rasero L, Guerretta L, Perfetti E, Clerico M. The late complications of totally implantable central venous access ports: the results from an Italian multicenter prospective observation study. *Eur J Oncol Nurs*. 2011;15:377–381.
- Heibl C, Trommet V, Burgstaller S, et al. Complications associated with the use of Port-a-Caths in patients with malignant or haematological disease: a single-centre prospective analysis. *Eur J Cancer Care (Engl)*. 2010;19:676–681.
- Hsieh CC, Weng HH, Huang WS, et al. Analysis of risk factors for central venous port failure in cancer patients. *World J Gastroenterol*. 2009;15:4709–4714.
- Beckers MM, Ruven HJ, Seldenrijk CA, Prins MH, Biesma DH. Risk of thrombosis and infections of central venous catheters and totally implanted access ports in patients treated for cancer. *Thromb Res Avr*. 2010;125:318–321.
- Toure A, Vanhems P, Lombard-Bohas C, et al. Totally implantable central venous access port infections in patients with digestive cancer: incidence and risk factors. *Am J Infect Control*. 2012;40:935–939.
- Chang YF, Lo AC, Tsai CH, et al. Higher complication risk of totally implantable venous access port systems in patients with advanced cancer: a single institution retrospective analysis. *Palliat Med*. 2013;27:185–189.