



## Cost and morbidity analysis of chest port insertion in adults: Outpatient clinic *versus* operating room placement



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### H I G H L I G H T S

- Chest ports can be safely placed under local anesthesia in the office setting.
- Fluoroscopy and ultrasound guidance are not necessary in the majority of cases.
- Port placement in the outpatient clinic is cost-effective.

### A R T I C L E I N F O

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### A B S T R A C T

**Background:** Totally implantable venous access devices (TIVADs) represent a convenient way for the administration of medications or nutrients. Traditionally, chest ports have been positioned by surgeons in the operating room, however there has been a transition over the years to port insertion by interventional radiologists in the radiology suite. The optimal method for chest port placement is still under debate.

**Materials and methods:** Data on all adult patients undergoing isolated chest port placement at our institution in a 12-year period were retrospectively reviewed. The aim of this cohort study was to compare cost and morbidity for chest port insertion in two different settings: outpatient clinic and operating room.

**Results:** Between 2003 and 2015 a total of 527 chest ports were placed in adult patients. Of them, 262 procedures were performed in the operating room and 265 procedures were undertaken in the outpatient clinic. Patient characteristics were similar and there was no significant difference in early (<30 days,  $p = 0.54$ ) and late complications (30–120 days,  $p = 0.53$ ). The average charge for placement of a chest port was 1270 Euros in the operating room *versus* 620 Euros in the outpatient clinic.

**Conclusion:** Our results suggest that chest ports can be safely placed in most patients under local anesthesia in the office setting without fluoroscopy or ultrasound guidance. Future randomized controlled studies may evaluate if surgeons or interventional radiologists should routinely perform these procedures in a dedicated office setting and reserve more sophisticated facilities only for patients at high risk of technical failure.

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## 1. Introduction

Totally implantable venous access devices (TIVADs) represent a

convenient way to take blood samples and administer medications, such as chemotherapy in cancer patients. Chest port placement has been traditionally performed by surgeons in the operating room. Over the years, there has been a transition to TIVAD placement by interventional radiologists in the radiology suite that has been reported with a lower complication rate [1], however studies on cost-effectiveness are still controversial [2,3].

Progress in medical oncology has expanded the indications for TIVADs placement, and it has been reported a 313% increase of long-term central venous access procedures from 1992 to 2011 [4].

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Moreover, while the inpatient hospital setting remains the primary place of service for all temporary central venous catheters, it has been observed a relative shift from the inpatient to the outpatient hospital services for all long-term central venous access devices [4]. To the best of our knowledge, only one report has evaluated results of port placement in the outpatient clinic [5]. At present, a greater need for efficient use of resources has increased the ability of healthcare providers to offer high quality of care at a much lower cost [6].

The aim of this study was to compare cost and morbidity for chest port insertion by a single surgical unit in two different settings: outpatient clinic and operating room.

## 2. Materials and methods

An institutional board approved this retrospective cohort study and informed consent was obtained from patients prior to each procedure. Data on all adult patients undergoing isolated chest port placement for the administration of chemotherapy at our institution between 2003 and 2015 were retrospectively reviewed. The medical records included information on name, age, diagnosis, type of anesthesia, type of catheter, post-procedure chest radiograph, early and late complications. All procedures were performed either in the operating room (group 1) or the outpatient clinic (group 2) by a senior surgeon or an experienced resident under direct supervision of a senior surgeon. The technique for port insertion was the same in both groups of patients. Types of central venous catheters used included Titanium Implantable Port (Bard Access Systems, Salt Lake City, USA) and Disticath (Disticlass Médical SA, Saint-Etienne, France). Access site was the right or left subclavian vein and all procedure were performed by percutaneous guidewire technique exclusively under local anesthesia (1% lidocaine). Patients in the operating room received monitored anesthesia care (MAC) administered by a nurse or an anesthesiologist. Patients in the outpatient clinic were monitored during the procedure with a pulse oximeter device. No fluoroscopy or ultrasound guidance was used both in the outpatient clinic and operating room. After port placement, a plain chest radiograph was obtained in the radiology unit and oral antibiotics were given to all patients.

Post-procedural complications were documented and divided in early (catheter tip malposition, arrhythmia, pneumothorax) that occurred within 30 days of port placement and late (infections, venous thrombosis, catheter occlusion) which were documented between 30 and 120 days after catheter insertion. In all cases of catheter tip malposition, repositioning was performed under fluoroscopy in the radiology unit by an interventional radiologist. Pneumothoraces were treated by observation alone or chest tube placement depending on size and symptoms.

Cost of port placement was derived from our hospital's Financial Department. Charges for the procedure included the device and other equipment costs, radiographic services, and other related charges. Costs of any subsequent procedure for treatment of complications were also considered in this study.

For each group, a sample size of at least 250 patients was included in the study, which was obtained using a power of 80% to determine a difference of 15%. Chi-square or *t*-test was used for the statistical analysis as appropriate and a probability value of less than 0.05 was considered significant. Quantitative variables were expressed as mean and range, while qualitative variables were reported as number and percentage.

## 3. Results

Between 2003 and 2015 a total of 527 chest ports were placed in adult patients at our institution. Of them, 262 procedures were

performed in the operating room between 2003 and 2012 (group 1) and 265 procedures were undertaken in the outpatient clinic between 2007 and 2015 (group 2). Male/female ratio was 136/126 and 144/121 in group 1 and 2, respectively ( $p = 0.57$ ). Mean age was 60.9 years (range 20–84) in group 1 and 59.6 years (range 19–90) in group 2 ( $p = 0.38$ ). Indication for catheter insertion was need for intravenous chemotherapy to treat a solid or hematological malignancy in 100% of cases, and patient characteristics were similar in both groups (Table 1). Average procedure time was 40 min for both groups of patients.

Post-procedural complications are presented in Table 2. Early complications occurred in 1.53% (4/262) of the operating room cases and in 2.26% (6/265) of the outpatient clinic cases. Tip malposition was observed in 7 cases (2 in group 1 and 5 in group 2), which required repositioning in the radiology unit under fluoroscopic guidance. Pneumothorax occurred in 3 cases: one patient (group 1) was treated conservatively, one patient (group 1) required hospitalization and chest tube insertion, and another patient (group 2) was managed in the outpatient clinic with chest tube placement. Late complications were recorded in 2.67% (7/262) and 1.89% (5/265) of group 1 and 2 patients, respectively. Infections occurred in 4 of the operating room patients and in 3 of the outpatient clinic cases. Venous thrombosis was observed only in one patient of group 1 who was successfully treated with low-molecular-weight heparin. Catheter occlusion occurred in 2 cases of each group, these patients required removal and repositioning that was performed in the outpatient clinic in all cases. The differences between early and late complications were not statistically significant ( $p = 0.54$  and  $p = 0.53$  for early and late complications, respectively).

The average charge for placement of a chest port was 1270 Euros in the operating room versus 620 Euros in the outpatient clinic (Table 3). Costs associated with treatment of early and late complications were similar between groups and differences were not statistically significant ( $p = 0.60$  and  $p = 0.17$  for early and late complications, respectively).

## 4. Discussion

Many patients require a long-term central venous access device for the administration of chemotherapeutic medications, nutrition, blood transfusions, or blood samples withdrawal. Most frequent indication is cancer, however TIVAD may be necessary for treatment of chronic infections, short bowel syndrome, and some hematological disorders. The technique for TIVAD placement has changed very little since it was first described in 1982 [7]. Venous access is usually obtained through percutaneous vein puncture and insertion of a guidewire (Seldinger). Recently, Biffi et al. [8] have evaluated which vein or technique is the best for TIVAD placement in a randomized three-arm trial. A total of 401 cancer patients were assessable: 132 with percutaneous land-mark access to the internal jugular, 136 with a ultrasound-guided access to the subclavian, and

**Table 1**  
Patient Characteristics.

Demographics	Operating Room (%)	Outpatient Clinic (%)	<i>p</i>
Patients	262	265	
Male	136 (52)	144 (54)	0.57
Female	126 (48)	121 (46)	
Mean age (years)	60.9	59.6	0.38
<b>Indications for port placement</b>			
Chemotherapy	262 (100)	265 (100)	
Solid tumor	228 (87)	242 (91)	0.11
Hematological tumor	34 (13)	23 (9)	

**Table 2**  
Early and late complications of chest port placement.

	Operating Room (%)	Outpatient Clinic (%)	<i>p</i>
<b>Early complications (&lt;30 days)</b>			
Tip malposition	2	5	
Arrhythmia	–	–	
Pneumothorax	2	1	
total	4 (1.53)	6 (2.26)	0.53
<b>Late complications (31–120 days)</b>			
Infection	4	3	
Venous thrombosis	1	–	
Catheter occlusion	2	2	
total	7 (2.67)	5 (1.89)	0.54

**Table 3**  
Charges for chest port placement (Euros).

	Operating Room (No. 262)	Outpatient Clinic (No. 265)	<i>p</i>
Device	225	225	0.98
Supplies (local anesthesia, MAC, operating room costs, procedure tray) <sup>a</sup>	990	340	<0.01
Radiographic services	55	55	0.98
Early complications <sup>a</sup>	300	395	0.60
Late complications <sup>a</sup>	593	745	0.17

<sup>a</sup> Costs are expressed in mean.

133 with a surgical cut-down access through the cephalic vein. The authors concluded that central venous access modality or site had no impact on either early or late complications when performed by experienced operators, however ultrasound-guided subclavian insertion was the most cost-effective method.

In our study, a retrospective series of 527 chest ports placed in adult patients by a single surgical unit either in the operating room or in the outpatient clinic was reviewed. Patients were not selected, indication for port insertion was the same in all cases, demographic characteristics were similar and there was no significant difference in early and late complications between groups. Although our cohorts of patients were treated in two different time periods, the same senior surgeons with broad experience in central venous catheterization were present at each procedure in both groups. To the best of our knowledge, only one study by Kincaid et al. [5] has evaluated results of long-term central venous catheter placement in adult patients in the outpatient clinic. A total of 558 patients were analyzed, this included 278 tunneled catheters and 280 totally implanted devices placed percutaneously with local anesthesia in the office setting without fluoroscopy or ultrasonography. The authors reported that real-time imaging can facilitate the placement of long-term vascular access devices, however in the great majority of patients these costly adjuncts are unnecessary. Our study like Kincaid's report is limited by the retrospective nature of data collection, however complication rate was very low in a large cohort of patients in both analyses. Another limitation is the length of follow-up that in our study was only 120 days, but we were able to obtain long-term follow-up data in all patients of each group. Moreover, though no psychological stress measurement was performed in our material, we usually observed a lower degree of anxiety in patients who underwent port placement in the outpatient clinic.

Several advances in catheter material and design have been obtained over the years, but there is no conclusive evidence of the superiority of a device over another [9]. There is increasing support in favor of ultrasound-guided vein puncture in order to reduce the rate of complications, such as arterial puncture and pneumothorax [9,10]. However, ultrasound guidance has been studied mainly for

the internal jugular access and there are only a few data on the subclavian vein puncture site [11]. Furthermore, though the use of ultrasound is considered the most effective method for vein cannulation, it is also more costly and data on cost-effectiveness are still lacking.

At present, progress in medical oncology has resulted in increased indications for TIVAD placement, and there is also the need for healthcare providers to deliver high quality of care at a much lower cost [4,6]. While chest port placement has been traditionally performed by surgeons in the operating room, there has been a transition to placement by interventional radiologists in the radiology suite. It has been reported that advantages of port insertion in the interventional radiology unit are the ability to provide this service at a lower cost with a lower complication rate [1,12]. Sticca et al. [2] performed a retrospective study comparing 276 central venous access ports placed by interventional radiologists with 92 ports placed by surgeons. There were no significant difference in complication rates, however reimbursement and charges were in favor of ports placed by surgeons. More recently, LeRoy et al. [3] have retrospectively compared 239 chest ports placed in the radiology suite with other 239 ports placed in the operating room. They concluded that while surgeons and interventional radiologists have similar rates of complications, comparisons of hospital costs demonstrated that ports placed in the interventional radiologist suite were more cost-effective.

In conclusion, our results suggest that TIVADs can be safely placed in most patients under local anesthesia in the office setting without fluoroscopy or ultrasound guidance. Comparison of hospital costs demonstrated that chest port placement in the outpatient clinic is more cost-effective. Future randomized controlled studies may evaluate if surgeons or interventional radiologists should routinely perform these procedures in a dedicated office setting and reserve more sophisticated facilities only for patients at high risk of technical failure.

### Ethical approval

An institutional board approved the study and informed consent was obtained from patients prior to each procedure.

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### Author contribution

Feo CF wrote the paper.

Feo CF, Fancellu A and Ginesu GC designed the study.

Bellini A and Cherchi G performed the research and acquired the data.

Scanu AM, Cossu ML and Porcu A analyzed the data and contributed to the revision of the manuscript.

### Conflicts of interest

The authors declare that they have no conflict of interest.

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