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Feasibility and safety of peripherally inserted central catheters in hospitalized elderly patients

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Background & Aims. The frequency of peripherally inserted central catheter use is increasing in elderly patients. Multiple comorbidities and changes in consciousness due to long-term hospitalisation can cause several problems. We aimed to determine the feasibility and safety, including the incidence of and risk factors for complications and accidental withdrawal, of using a peripherally inserted central catheter in hospitalised elderly patients.
Methods. A retrospective, single-centre study of elderly patients with peripherally inserted central catheters was performed between July 2015 and July 2020. We analysed the patient-, device-, and procedure-related characteristics to determine the feasibility and safety of the insertion procedure, including complications and accidental withdrawal. Odds ratios (ORs) with 95% confidence intervals were generated.
Results. Among 703 patients, insertion of peripherally inserted central catheters was successful in 689 (98.00%) patients. The procedure was unsuccessful in 14 (1.99%) patients. Among those who underwent successful catheter insertion, 52 (7.55%) patients developed procedure-related complications. Logistic regression analysis revealed that complications were associated with pneumonia (OR, 2.136), renal insufficiency (OR, 2.518), chronic obstructive pulmonary disease (OR, 3.050), and double-lumen catheters (OR, 5.524). Accidental withdrawal occurred in 63 (9.14%) patients and was associated with delirium (OR, 2.788) and admission for orthopedic surgery (OR, 2.400).
Conclusions. Use of peripherally inserted central catheters are feasible and safe for hospitalised elderly patients. Comorbidities such as pneumonia, renal insufficiency, and chronic obstructive pulmonary disease were risk factors for complications, and delirium was a risk factor for accidental withdrawal.

Key words: aged, catheterization peripheral, central venous catheters, vascular access devices, device removal

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INTRODUCTION

Peripheral venous access can sometimes be difficult to use for a variety reasons. As the frequency and duration of hospitalisations in elderly patients have increased, effective and reliable venous access has become important in the treatment of geriatric diseases. Elderly patients often have multiple comorbidities that may require long-term hospitalisation, parental

nutrition, chemotherapy, long-term antibiotic treatment, and blood transfusion. Peripherally inserted central catheters (PICCs) are used in clinical practice for reliable intermediate and long-term venous access [1-3].

Although central venous access through the jugular vein or subclavian vein has been used for a long time, a PICC has advantages over this traditional mode of access, with lower rates of complications such as pneumothorax, haemothorax, and catheter-related infection, as well as elimination of unnecessary discomfort caused by the regular change of peripheral venous access. For these reasons, the frequency of PICC use is increasing [3-4]. Indications for PICC use include patients requiring intravenous access for more than 14 days, clinically stable patients requiring intravenous therapy with peripherally incompatible solutions, patients requiring continuous infusions of a vesicant medication, parental nutrition, patients requiring chemically irritating or non-peripherally compatible solutions for any duration, and patients who are undergoing palliative treatment, actively dying, or in hospice requiring intravenous solutions [5]. The use of PICCs has been approved by the Food and Drug Administration (FDA) for up to 3-12 months. Most PICCs remain in place and are used for several months, with the actual period of use affected by the type of catheter, method of insertion, compliance of the patient, and competence of healthcare professionals in the maintenance of the device [6].

Conventionally, blind ultrasonography (US)-guided bedside PICC insertion has been performed by trained physicians via deep veins such as the basilic or brachial vein [6,7]. However, because of the uncertain anatomical pathway from the axillary vein to the superior vena cava (SVC), including the presence of venous occlusion or stenosis that are often encountered in elderly patients, blind US-guided bedside PICC insertion is often difficult. Fluoroscopy-guided PICC insertion is often necessary. US-guided venous access and fluoroscopy-guided PICC insertion could be helpful in successful guidewire advancement and in reducing catheter tip malposition by ensuring the appropriate location of the guidewire tip during the procedure [8].

In elderly patients, abnormal anatomical pathways and venous conditions can cause failure of PICC insertion procedures. Multiple comorbidities and changes in consciousness due to long-term hospitalisation can likewise cause problems. Most studies on PICCs have focused on specific diseases and complications, but studies on the various problems that arise in the elderly are limited. Therefore, we conducted a retrospective, single-centre study, in which we first analysed the patient-, device-, and procedure-related characteristics of PICC insertion. We then determined the feasibility and safety of PICC insertion, including the incidence of and risk factors for complications and the rate of accidental withdrawal in hospitalised elderly patients, according to their functional capacity and comorbidities.

PATIENTS AND METHODS

Study design and data collection

A retrospective, single-centre study of elderly patients who underwent PICC insertion was conducted to determine the feasibility and safety of the procedure. The study included an analysis of the incidence of and risk factors for complications, as well as the rate of PICC removal, in elderly patients from July 2015 to July 2020. We retrospectively reviewed the electronic medical records of patients over 65 years of age who underwent PICC insertion at Busan Veterans Hospital. The study was approved by the Institutional Review Board of Busan Veterans Hospital (Number: 2020-04) and the requirement for informed consent was waived due to the retrospective nature of the study. The following aspects of feasibility were evaluated: Implementation rate. The number and ratio of subjects who underwent PICC in all patients aged 65 or older who were hospitalized during the study period. The success rate of the procedure: The number and proportion of successful procedures amlong all subjects who attemped PICC insertion. Because of the specifity of the hospital, the economic feasibility could not be evaluated because the most of the subjects were people of national merit who did not pay for the hospital. All patients were monitored for PICC removal, death, termination of treatment, or discharge. Complications were monitored and corresponding data were collected by the patients' physicians and nurses. Patient-related data were collected at baseline and classified according to the following categories: age, sex, comorbidities, entrusted medical department, physical activity according to the Eastern Cooperative Oncology Group (ECOG) performance status scale, presence of delirium, and reason for PICC insertion. The level of consciousness was evaluated according to the Glasgow Coma Scale, which was periodically evaluated by nurses during hospitalisation. The diagnosis of delirium was made after referral to a psychiatrist or neurologist. Procedure-related data were collected by physicians and included the following: success rate, cause of failure, vein entry, side of insertion, tip position, and dwell time.

Procedure details of PICC placement

All procedures were performed by experienced interventional cardiologists at the cardiac catheterisation laboratory under ultrasonographic and fluoroscopic guidance. The procedures were performed under aseptic conditions. At least one assistant was present during the procedures. Local anaesthesia was induced using 2%

lidocaine. Most PICC insertions were performed using a 4 French (Fr) single-lumen catheter; a 5 Fr double-lumen catheter was used in patients undergoing chemotherapy, when requested by the physician. The choice of puncture site was made at the operator's discretion. In routine practice, the selection was based on vein diameter with the help of ultrasound (vein diameter > 5 mm). The preferred side for PICC insertion was the right arm; however, if the vein was too small or could not be found on ultrasound, or if the patient had an arteriovenous fistula (AVF) for haemodialysis on the right arm, we selected the left arm for PICC insertion. After puncture of the target vein under ultrasonographic guidance, the guidewire course and position were controlled via fluoroscopy, and the catheter length was estimated to determine the optimal tip position. After proper insertion, the catheter tip was checked via fluoroscopy, and the puncture site was dressed using a catheter stabilisation device.

Endpoints

Complications were evaluated as mechanical, early, and late complications. Occlusion, damage or breakage, and catheter migration were evaluated as mechanical complications. Bleeding that required transfusion, pneumothorax, haemothorax, pericardial effusion or cardiac tamponade, and new-onset arrhythmia were considered early complications, while infection, deep vein thrombosis, and phlebitis were considered late complications. Catheter withdrawal was divided into voluntary and accidental withdrawals. Withdrawal due to death, termination of treatment during admission, discharge, and complications was assessed as voluntary withdrawal. The PICC dwell time was calculated from the date of insertion to the date of withdrawal.

Statistical analysis

Continuous variables are presented as mean ± standard deviation (SD). Categorical variables are presented as counts (percentages). The associations between patient-, device-, and procedure-related characteristics and complications, including accidental withdrawal, were analysed using logistic regression models, and the results are presented as adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Characteristics with a p-value < 0.05 in the logistic regression analysis were considered statistically significant. All statistical analyses were performed using IBM SPSS (Version 25, Armonk, NY, USA).

RESULTS

Baseline patient-, device-, and procedure-related characteristics are summarised in Table I.

Age and sex distribution

From July 2015 to July 2020, the total number of inpatients was 29,565. Of these, 26,937 (91.11%) were 65 years of age or older at the time of admission. Among all inpatients, PICC insertion was attempted in 781 patients (2.64%) and among all inpatients aged 65 or older, PICC insertion was attempted in 703 patients (2.61%). Among the 703 patients for whom PICC insertion was attempted, the mean age was 77.56 ± 7.38 (range, 65-96 years), and 623 (88.62%) were male. The procedure was successful in 689 (98.00%) patients. Among the 14 (1.99%) patients with failed procedures, the reasons for failure were small vein size unsuitable for the procedure in 5 (0.71%) patients, occlusion of the vein in 5 (0.71%), and severe stiffness in the upper arm in 4 (0.57%).

Diagnosis and indication

Among 689 patients who underwent successful PICC insertion, the most frequent comorbidity was hypertension (n = 455, 66.03%), followed by diabetes (n = 283, 41.07%), a history of malignancy (n = 257, 37.30%), coronary artery disease (n = 233, 33.81%), pneumonia (n = 148, 21.48%), stroke (n = 138, 20.20%), and heart failure (n = 92, 13.35%). Many of patients were primarily managed by the department of Gastroenterology (n = 161, 23.36%), followed by Family Medicine (in charge of hospice care) (n = 133, 19.30%), Orthopedic Surgery (n = 106, 15.38%), and Cardiology (n = 89, 12.91%). At the time of insertion, 526 (76.34%) patients were admitted in the general wards, 127 (18.43%) in hospice wards, and 46 (6.67%) in intensive care units. With regard to the level of patient consciousness at the time of insertion, 535 (77.64%) patients were alert, 71 (10.30%) were drowsy, 68 (9.87%) were stuporous, 26 (3.77%) were semicomatose, and 3 (0.44%) were comatose. Meanwhile, 56 (8.13%) patients suffered from delirium during admission. At the time of insertion, the patients' ECOG performance scores were as follows: 0 in 7 (1.02%) patients, 1 in 130 (18.87%), 2 in 194 (28.16%), 3 in 222 (32.22%), and 4 in 136 (19.74%). The indications for PICC insertion were investigated, and multiple reasons were considered. The most frequent indications for insertion were difficult venous access in 576 (83.59%) patients, long-term antibiotic administration in 141 (20.46%), parental nutrition in 114 (16.55%), and long-term hospitalisation in 84 (12.19%).

Overview of the PICC procedure

Of the 689 patients who had successful PICC insertions, 666 (96.66%) had single-lumen PICCs inserted while 23 (3.34%) had double-lumen PICCs inserted. A

Table I. Baseline characteristics of elderly patients.

Characteristics	Total (n = 689)
Patients-related	
Age, years	77.56 ± 7.38
Male gender, n (%)	623 (88.62%)
Cormorbidities, n (%)	
Hypertension	455 (66.03)
Diabetes mellitus (type II)	283 (41.07)
History of malignancy	257 (37.30)
CAD	233 (33.81)
Pneumonia	148 (21.48)
CVA	138 (20.02)
Heart failure	92 (13.35)
Renal insufficiency	59 (8.56)
Entrusted department, n (%)	
Gastroenterology	161 (23.36)
Family medicine (in charge of hospice)	133 (19.30)
Orthopedic surgery	106 (15.38)
Cardiology	89 (12.91)
Level of consciousness, n (%)	
Alert	535 (77.64)
Drowsy	71 (10.30)
Stuporous	68 (9.87)
Semicomatose	26 (3.77)
Comatose	3 (0.44)
Presence of delirium, n(%)	56 (8.13)
ECOG performance status, n(%)	
0	7 (1.02)
1	130 (18.87)
2	194 (28.16)
3	222 (32.22)
4	136 (19.74)
Indication for PICC, n (%)	
Difficult venous access	576 (83.59)
Antibiotics	141 (20.46)
Parental nutrition	114 (16.55)
Long hospital admission	84 (12.19)
Dwell time (day)	28.52 ± 25.84
Device-related	
PICC type, n (%)	
4-Fr, Single lumen	666 (96.66)
5-Fr, Double lumen	23 (3.34)
Procedure-related	
Right arm, n (%)	619 (89.84)
Vein entry, n (%)	
Basilic vein	385 (55.88)
Brachial vein	294 (42.67)
Cephalic vein	10 (1.45)
Tip position at cavoatrial junction, n(%)	677 (98.26)

PICC: peripherally inserted central catheter; DM: diabetes mellitus; CAD: coronary artery disease; CVA: cerebrovascular attack

total of 619 (89.84%) patients had PICC insertion on the right side while 70 (3.34%) had PICC insertion on the left side. In cases with a small right upper arm vein, occlusion or severe stenosis of the right proximal vein, or an arteriovenous fistula for haemodialysis in the right arm, the PICC was placed on the left side. A total of 385 (55.88%) catheters were inserted into the basilic vein, 294 (42.67%) in the brachial vein, and 10 (1.45%) in the cephalic vein. All the procedures were performed under ultrasonographic and fluoroscopic guidance. A total of 677 (98.26%) catheter tips were placed in the distal third of the SVC and the cavoatrial junction. In cases with anatomical abnormalities (stenosis or occlusion) of the proximal vein (subclavian or axillary), the procedure was changed to a midline catheter. All 689 patients were monitored until the PICC was removed. The median PICC dwell time was 28.52 ± 25.84 days (range, 1-194 days).

Complications

The complications and reasons for PICC withdrawal are summarised in Table II. Of the 689 patients who had successful insertions, 52 (7.55%) developed PICC-related complications. With regard to mechanical complications, 26 (3.77%) were occluded, 2 (0.29%) were damaged or broken, and 6 (0.87%) involved catheter migration. Early complications included only 1 (0.15%) nerve injury and no bleeding requiring transfusion, pneumothorax, haemothorax, cardiac tamponade, or

Table II. Complications and reasons for withdrawal of PICC.

Characteristics	Total (n = 689)
Complications, n (%)	52 (7.55)
Mechanical complications, n (%)	
Occlusion	26 (3.77)
Damaged or broken	2 (0.29)
Catheter migration	6 (0.87)
Early complications, n (%)	
Nerve injury	1 (0.15)
Late complications, n (%)	
Infection	7 (1.02)
Deep vein thrombosis	1 (0.15)
Phlebitis	3 (0.44)
Reasons for PICC withdrawal	
Voluntary withdrawal n (%)	626 (90.86)
Death	200 (29.02))
Termination of treatment	189 (27.43)
Discharge	212 (30.77)
Mechanical complications	17 (2.47)
Early or late complications	8 (1.16)
Accidental withdrawal	63 (9.14)

PICC: peripherally inserted central catheter

arrhythmia. Late complications included infection in 7 (1.02%) patients, deep vein thrombosis in 1 (0.15%) patient, and phlebitis in 3 (0.44%) patients.

Logistic regression analysis (summarised in Table III) revealed that complications were associated with pneumonia (OR 2.136, 95% CI 1.055-4.324, p = 0.035), renal insufficiency (OR 2.518, 95% CI 1.022-6.204, p = 0.045), and chronic obstructive pulmonary disease (COPD) (OR 3.050, 95% CI 1.019-9,129, p = 0.046). Importantly, complications were strongly associated with the number of catheter lumens, with 5 Fr double-lumen catheters presenting a greater risk for complications than single-lumen catheters (OR 5.524, 95% CI 2.065-14.777, p = 0.001).

Voluntary withdrawal of the catheter occurred in 626 (90.86%) cases. Of these, 200 (29.02%) cases were associated with death, 189 (27.43%) were associated with termination of treatment during admission, and 212 (30.77%) were discharged. With regard to complications resulting in catheter withdrawal, 17 (2.47%) catheters were removed due to mechanical problems and 8 (1.16%) were removed due to early or late complications. Accidental withdrawal of the catheter occurred in 63 (9.14%) patients. Logistic regression analysis (summarised in Table IV) revealed that accidental withdrawal was associated with delirium (OR 2.788, 95% CI 1.359-5.723, p = 0.005) and with orthopedic surgery admission (OR 2.400, 95% CI 1.044-5.518, p = 0.039). Patients with a 5 Fr double-lumen PICC insertion had a lower risk of accidental withdrawal (OR 0.024, 95% CI 0.066-0.776, p = 0.018).

DISCUSSION

The PICC was first introduced in 1975 to address complications related to long-term central venous catheters [9]. Although traditional central venous access has been used for a long time, a PICC has advantages such as lower rates of complications and the elimination of unnecessary discomfort caused by regular change of peripheral venous access [3,4]. The PICC has been widely used in clinical practice for the administration of drugs, blood, and parental nutrition. The use of a PICC is often necessary for the treatment of elderly patients because of comorbidities, long-term hospitalisation, and difficulty in peripheral venous access. However, problems continue to arise often.

In our study, of all the patients for whom the use of PICC was attempted, 90.1% were aged 65 years or older, with a mean age of 77.56 years. Our study patients were older than those included in other PICC studies, and this is believed to have significant implications. While our study included more male patients, it appears to be a reflection of the characteristic of hospitals to have more male patients. The success rate of the PICC procedure was 98.00%, and failure of the procedure was due to small or no veins visualized, venous occlusion, or severe stiffness of bilateral arms. In 12 cases in which the tip of the catheter was not positioned at the cavoatrial junction due to anatomical abnormalities, the procedure was changed to a midline catheter insertion after venography at the distal part of the upper arm vein. This is an important point in our study because there are only a few reports showing the success rate of PICC insertion and the reasons for failure of the procedure.

Difficult venous access was the most commonly documented indication for PICC insertion, and long-term hospitalisation is another common reason in elderly patients. Typically, the basilic vein is the first choice because it is superficial and less tortuous than the cephalic vein; the brachial vein is often the second choice, because the vessel is deeper and in close proximity to the brachial artery [10]. In our study, most PICC procedures were performed using the basilic vein, but more PICC insertions were performed using the brachial vein than expected. Since our study included elderly patients, it is likely that the basilic vein was not suitable for various reasons in a number of cases.

In our study, 59 patients who underwent PICC insertion had renal insufficiency, 21 of whom had a creatinine clearance of less than 40 mL/min. In patients who may require renal replacement therapy, prior PICC placement is among the strongest predictors of AVF failure [11]. Therefore, guidelines discourage the use of PICC in these patients [12]. An institutional systematic intervention is needed to prevent PICC procedures in patients who require vein preservation for renal replacement therapy and to allow PICC use in appropriate situations.

Complications occurred in 52 (7.55%) patients. Mechanical complications were the most common, and occlusion occurred in 26 patients. Catheter damage or breakage occurred in 2 patients, and catheter migration occurred in 6 patients. The latter was caused by overfilled fluid lines and was detected by the medical staff before accidental withdrawal. One patient experienced nerve injury accompanied by numbness after the procedure, but fully recovered approximately 2 weeks later. No cases of pneumothorax, haemothorax, cardiac tamponade, or arrhythmia occurred. The lower rate of early complications in our study compared to those in other studies may be due to the fact that all PICC procedures were performed under ultrasonographic and fluoroscopic guidance, and the exact location of the catheter tip was visible.

A prospective study of cancer patients with PICCs found that 51.4% of patients developed catheter-related thrombosis on ultrasound, of whom 45.6% were

Table III. Logistic regression analysis of risk factors associated with complications.

Variables	OR	95% CI	P-value
Patient-related			
Delirium	1.106	0.381-3.206	0.854
Level of consciousness			
Alert	1	Ref	Ref
Drowsy	7.734	0.683-87.585	0.099
Stuporous	3.875	0.315-47.722	0.290
Semicomatose	10.333	0.719-148.536t	0.086
Comatose	5.500	0.333-90.729	0.233
ECOG performance status			
0	1	Ref	Ref
1	1.012	0.463-2.215	0.941
2	1.210	0.462-3.169	0.697
3	1.177	0.493-2.809	0.713
4	1.022	0.450-2.321	0.954
Comorbidities			
Hypertension	0.855	0.429-1.701	0.654
DM	0.667	0.334-1.330	0.250
History of malignancy	1.693	0.860-3.335	0.128
CAD	1.489	0.757-2.930	0.249
Pneumonia	2.136	1.055-4.324	0.035
CVA	1.717	0.822-3.588	0.151
Heart failure	1.452	0.621-3.393	0.389
Renal insufficiency	2.518	1.022-6.2-4	0.045
COPD	3.050	1.019-9.129	0.046
Entrusted department			
Gastroenterology	0.869	0.350-2.156	0.761
Family medicine	1.337	0.540-3.308	0.530
Orthopedic surgery	1.950	0.455-8.344	0.368
Cardiology	0.758	0.210-1.918	0.558
Neurosurgery	1.847	0.550-6.197	0.312
Device-related			
Catheter type (5Fr)	5.524	2.065-14.777	0.001
Procedure-related			
Vein entry			
Right basilic vein	1	Ref	Ref
Right brachial vein	0.718	0.366-1.408	0.335
Right cephalic vein	0.817	0.426-1.307	0.324
Left basilic vein	0.541	0.151-1.940	0.345
Left brachial vein	0.232	0.090-0.599	0.003
Left cephalic vein	0.000	0.000	NA

PICC: peripherally inserted central catheter; DM: diabetes mellitus; CAD: coronary artery disease; CVA: cerebrovascular attack; COPD: chronic obstructive pulmonary disease; OR: odds ratio; CI: confidence interval; NA: not applicable

asymptomatic [13]. In cases with catheter-related thrombosis, catheter removal alone resulted in reduced major bleeding but more secondary venous thromboembolic events [14]. A review of 11 studies found that PICCs were associated with a 2.6-fold greater risk of thrombosis than other types of central venous catheters [15]. Among 332 patients who underwent ultrasound at catheter removal or at 28 days, thrombosis was detected in 72%, whereas symptomatic deep vein thrombosis occurred in only 4% [16].

In our study, the rate of PICC-related thrombosis was lower than those reported in other studies. This result

Table IV. Logistic regression analysis of risk factors associated with accidental withdrawal of PICCs.

Variables	OR	95% CI	P-value
Patient-related			
Delirium	2.788	1.359-5.723	0.005
Level of Consciousness			
Alert	1	Ref	Ref
Drowsy	0.382	0.113-1.289	0.121
Stuporous	1.079	0.439-2.647	0.869
Semicomatose	2.179	0.567-8.371	0.257
Comatose	0.999	NA	NA
ECOG performance status			
0	1	Ref	Ref
1	0.388	0.041-3.689	0.410
2	0.285	0.030-2.682	0.273
3	0.877	0.099-7.790	0.906
4	1.022	0.046-4.557	0.506
Comorbidities			
Hypertension	1.073	0.548-2.102	0.836
DM	1.179	0.634-2.191	0.603
History of malignancy	0.541	0.238-1.227	0.142
CAD	0.704	0.360-1.378	0.306
Pneumonia	0.611	0.264-1.414	0.250
CVA	1.219	0.616-2.414	0.569
Heart failure	0.735	0.243-2.221	0.586
Entrusted department			
Gastroenterology	0.841	0.297-2.386	0.745
Family medicine	1.159	0.506-2.654	0.727
Orthopedic surgery	2.400	1.044-5.518	0.039
Cardiology	2.435	0.898-6.731	0.086
Neurosurgery	1.972	0.988-3.938	0.054
Device-related			
Catheter type (5Fr)	0.266	0.066-0.776	0.018
Procedure-related			
Vein entry			
Right basilic vein	1	Ref	Ref
Right brachial vein	1.313	0.796-2.334	0.260
Right cephalic vein	1.185	0.145-9.675	0.874
Left basilic vein	0.333	0.044-2.526	0.288
Left brachial vein	0.610	0.140-2.660	0.510
Left cephalic vein	0.000	0.000	NA

DM: diabetes mellitus; CAD: coronary artery disease; CVA: cerebrovascular attack; OR: odds ratio; CI: confidence interval; NA: not applicable

was attributed to several reasons. First, efforts were made to use a larger vein for the venous entry. Second, the number of patients with a malignancy on treatment predisposed to develop thrombosis was smaller in our study than in other studies. Also, ultrasonography was used for evaluation only when clinical thrombosis was suggested. Finally, in case of catheter occlusion, the catheter was removed without ultrasonographic evaluation.

US-guided bedside PICC insertion did not show favourable outcomes and was associated with serious complications of catheter tip malposition, which can increase the risk of complications such as thrombosis, arrhythmia, cardiac tamponade, and catheter malfunction [8,17]. In logistic regression analysis of complications and variables, patients with pneumonia, renal insufficiency, and COPD had an increased risk of complications. Catheter occlusion was the most common

complication in patients with pneumonia and renal insufficiency, occurring in 6 cases. With COPD, there were 2 cases of catheter occlusion and 3 cases of catheter migration.

Similar to a previous study, the risk of catheter-related thrombosis increased when a multi-lumen PICC was used compared to a single-lumen PICC [18]. In our study, the risk of complications, such as catheter occlusion, increased by 5.524 times when a double-lumen catheter was used. Minimisation in the use of multi-lumen PICCs and institutional efforts to ensure the use of PICCs at a clinically appropriate time could improve the results.

There was no studies comparing the implementation and success rate of PICC insertion according to the age, and in a study showing the results of complications, the incidence of PICC-related occlusion increased 4.19 times in the elderly aged 65 or older [19], but in other studies, more adverse events occurred in the younger group [20]. In this study, statistical significance could not be obtained in comparison with age because most of the subjects were over 65 years of age.

Voluntary withdrawal of PICCs showed similar results in cases involving death, termination of treatment during admission, and discharge. Complications related to voluntary withdrawal were observed in 25 patients. Accidental withdrawal of peripheral venous lines occurs frequently in the elderly due to changes in consciousness. In our study, accidental withdrawal of PICCs was not related to the level of consciousness, but the risk increased by 2.788 times with the presence of delirium during hospitalisation, and by 2.400 times in orthopedic surgery patients. Orthopedic surgery patients often have a long hospital stay for rehabilitation after surgery and have a more active hospital life than other patients, which is the reason for the increased risk. Patients with double-lumen PICCs had a lower risk of accidental withdrawal. This is probably because these patients, who were on chemotherapy, were well aware of the importance of intravenous catheters and were careful not to withdraw the catheter.

Several limitations of our study should be considered when interpreting the results. The retrospective nature of our study limits proper assessment. There were differences in the documentation patterns within hospitals using medical records for data collection. The selection of multiple indications showed weakness in evaluating clear indications. Because of the specificity of hospital that treat people of national merit, most of the subjects were male and aged 65 or older, so comparative studies were not conducted according to age and gender, and economic feasibility could not be evaluated because patients did not pay for hospital.

In the future, it is thought that a prospective study is needed to evaluate feasibility and safety of PICC insertion according to age for all inpatients.

CONCLUSIONS

The success rate of PICC insertion in elderly patients and the clinical characteristics in these patients were analysed, along with the factors related to complications and accidental withdrawal. In terms of clinical practice, healthcare providers should be aware of these characteristics and risk factors in elderly patients. Special attention should be provided to elderly patients with PICCs.

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Conflict of interest
The Authors declare no conflict of interest.

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Author contributions
Sang Hee Kim: conceptualization and methodology, data analysis, funding acquistion, validation, writing original draft and review.

Su Hong Kim: data curation, investigation, projection administration and supervision, writing original draft, review and editing.

Ethical consideration
This study was approved by the Institutional Ethics Committee (Busan Veterans Hospital, Number : 2020-04). The research was conducted in accordance with the requirements of the World Medical Association's Declaration of Helsinki. The requirement of written informed consent was waived due to the restrospective nature of study.

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