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"A Study of Indications and Complications of Central Venous Catheterization in Patients of Intensive Care Unit"

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Abstract
Background: *Central venous catheters play a vital role in medical practice enabling clinicians to monitor and support the efforts of the body to stabilize the circulation and provide nutritional supplements.*
Objectives: *This study was conducted to study various indications, sites of insertion and complications of central venous catheterization.*
Methods: *This article reviews our experience with 609 central venous catheters (CVC) inserted in 589 critically ill adult patients of Medical Intensive Care Unit (MICU) or Artificial Kidney Dialysis Unit (AKD) following a standard protocol during study period. Various indications, insertion sites, type, size and material of catheter used, duration and reason of removal of catheter, complications were all documented. Chi square test was used to calculate the statistical significance and a P value of 0.05 or less considered statistically significant.*
Results: *Commonest indication for central venous catheterization (CVC) was hemodynamic monitoring (93.9%) and most common site of insertion was cephalic vein (62.07%). Complications occurred in 165 (27.09%) out of 609 CVC. Excess bleeding (27.8%) was the commonest complication, followed by venous thrombosis (20.6%), catheter related sepsis (CRS) (15.7%) and arterial puncture (13.3%).*
Conclusions: *Platelet count and coagulation profile should be checked before the procedure. Central venous catheterization performed under standard protocol is a very effective and safe route of providing venous access. This procedure should be performed under strict aseptic precautions with minimal percutaneous punctures to decrease complication rates.*
Keywords: *Central Venous Catheterization, Indication, Sites, Complications, MICU and AKD.*

I. Introduction

Central venous catheters (CVC) are commonly used in intensive care units. In face of extremely wide spread use of invasive central venous catheterization, it is essential to be familiar with the various indications, access sites and complications arising out of this procedure. Catheters are currently indicated for a) monitoring of central venous pressure in acutely ill patient to quantify fluid balance and for deciding ionotropic support, b) volume resuscitation, c) hemodialysis/plasmaphereis, d) lack of peripheral access, e) giving irritant drugs, f) long term venous access,g) IV procedures eg. Pacemakers,etc. Widespread use of the catheters led to the emergence of various complications such as arterial puncture, venous thrombosis, catheter related sepsis, pneumothorax, etc. The present study was carried out to assess purpose of the procedure and problems of central venous catheterization in an intensive care unit.

II. Material And Methods

This was a prospective observational study carried out on patients who underwent central venous catheterization for any purpose in Medical Intensive Care Unit (MICU) and Artificial Kidney Dialysis Center (AKD) over a period of 15 months, after approval of Institutional Ethical committee of the hospital. Patients who underwent the procedure of CVC in general medical ward of this hospital or outside this tertiary care center were excluded from the study. The standard protocol for insertion of central venous catheter in the intensive care unit (MICU/AKD) was strictly followed. A valid written informed consent from patients or relatives was taken for each procedure. Site of insertion was based on indication, vital parameters, clinical condition of patient etc. After anatomical landmarks were visualized, CVC was inserted with strict aseptic precautions (sterile hand wash, mask, gloves, surgical gown and cap). Skin was prepared and disinfected with chlorhexidene and povidine iodine. Lidocaine (1%) was used as local anaesthesia. Catheters were inserted either by Catheter through the Cannula Technique for single lumen (16G) catheter or by Seldinger Technique for multilumen/dialysis (7Fr) catheters. CVC was introduced during exhalation to minimize the possibility of air embolization. If the veins were not accessible, help of uitrasonography was taken. Position of the catheter was

confirmed by return of venous blood. Chest radiograph was done post-procedure. Catheters were sutured and covered with a sterile dressing by utilizing optimal aseptic precautions. The catheter lumen was flushed on a periodic basis and also when blood sampling was done or drugs were administered. Duration for which catheter were kept in situ (days) was noted.

During Catheter removal the skin was cleaned with 70% alcohol. The terminal two to three inches of CVC were collected in the tube and transported to the lab as soon as possible[1]. Catheters were removed with patient holding his breath to prevent air embolization and lying in head low position. Catheter lumen or exit wound was immediately occluded to prevent air entry. Antibiotic ointment was applied to the exit wound, air-tight occlusive dressing was applied. Patient was asked to remain flat in bed for 30 minutes after CVC removal and was monitored for any untoward complications. Patients were followed periodically for any local sign of infection or other delayed complication. Reason for removal of CVC were a) it was no longer needed b) patient died c) complications occurred d) catheter became non-functional.

Lab profile and imaging**:** Routine investigation like hemoglobin, platelets count, total leukocyte count, Prothrombin time, International randomized number, Activated partial thromboplastin time, Bleeding time, Clotting time, Serum Electrolytes were sent. Chest X-Ray was done immediately after insertion of catheters to look out for catheter tip position and complications if any. Other imaging modalities were used when a particular complication occurred like USG Venous Doppler, CT/MR Venography, Fluoroscopy (for irretrievable guide wire or catheter).

Catheter tip processing: Extra luminal Maki's roll over plate method[2] and endo-luminal catheter flush culture were used for processing[3] and further tests and cultures were specially done when catheter related sepsis was suspected. Interpretation[4]: Agar plates were examined at 24 hours, 48 hours and 72 hours. Significant growth was defined as ≥ 15 colony forming units (CFU) by Maki's roll plate method or ≥ 100 CFU/ml by the catheter flush method. Blood (10 ml) was collected within 48 hours of catheter insertation under aseptic precautions in a BacT bottle and analyzed using the BacT ALERT system. Documentation: demographic characteristics of patients, clinical history, vital parameters, general and systemic examination, diagnosis, investigations and treatment given were recorded.CVC indication, sites of insertion ,number of attempt, type of catheters, technique of insertion, duration of catheter, time of removal and complications(immediate and delayed) were documented. **Success of procedure:** The catheter course was considered successful, if the catheter was removed after completion of the course of therapy or if the patient died due to underlying disease with no evidence of a catheter complication. **Premature termination:** Catheter removal was considered premature if it was removed before conclusion of therapy.

Data analysis: Chi square test was used to calculate the statistical significance of the accumulated data comparing various parameters and a P value of 0.05 or less was considered statistically significant.

III. Result

In the present study, 903 patients were admitted in MICU/AKD over a period of 15 months. Of these 883 had a central line in place; Amongst them, the catheter was placed in general medical ward in 230 patients before transfer to MICU/AKD and 14 patients had undergone the procedure outside this tertiary care and hence were excluded from the study. A total of 589 patients were meeting the criteria and were included, (535 from MICU and 64 from AKD). During the study period, 609 central venous catheters were inserted in 589 patients hospitalized in the intensive care unit (MICU/AKD).

Age & Sex: (Table 1)

Age of the patients included ranged from 12 to 90 years with average age being (36.07±16.73). 343 (58.2%) were males and 246 (41.8%) were females. Majority were in the age group of 21-30 years. There were only 5 patients who were >80 years of age.

Indications: (Table 2)

Overall the most common indication for catheter insertion was hemodynamic monitoring (93.9%) followed by volume resuscitation in (23.6%), hemodialysis /plasmapheresis in (10.5%), administration of vasoirritant/incompatible drugs in (1.8%), lack of venous access (0.6%) and total parenteral nutrition(0.3%).

Sites of Insertion: (Table 3)

Majority of the catheters (68.6%) were inserted from peripheral arm veins like basilic, cephalic followed by jugular (29.8%)and subclavian vein (1.4%). Most of catheters were inserted from right side (89.8%). Only (10.1%) were inserted from left side. Femoral vein and other site of insertion were not used. The most common way to localize the veins for central venous catheterization in this study was use of external anatomical landmark (99.7%) and USG Doppler was used only in 2 patients for venous access localization (0.3%).

Number of attempts:

87.0% catheters could be inserted on first attempt, while a second attempt was required in 10.3%. However in 1.8% cases 3 attempts and in 0.8% patients 4 attempts were required.

Types of catheters:

482 (79.1%) out of 609 catheters were single lumen peripherally inserted catheters of 16G size , followed by 191 (31.4%) 7F multi-lumen/dialysis catheters. Implantable ports and tunnelled catheters were not used in this study. All catheters which were used were made of polyurethane.

Complication profile: (Table 4)

Complications occurred in 165 (27.09%) out of 609 catheters inserted whereas 444 (72.91%) catheters inserted were without any complications. No deaths were related to central venous catheterization. Complications were common in males (78.1%) as compared with females (21.8%). Out of 165 complications observed, the most common was excess bleeding (27.8%), followed by thrombosis (20.6%). Other complications which were observed were catheter-related sepsis (15.7%), arterial puncture (13.3%), hematoma formation (5.4%), incorrect catheter tip position (4.8%), infection at exit-site (4.2%), mechanical phlebitis (2.4%), pneumothorax (1.8%), pleural effusion (1.2%) and embolization/irretrievable CVC guide wire (1.2%). One case of damage to neighboring structure resulting in Horner's syndrome and one case of supraventricular tachycardia was observed.

Table 5: Platelet count was important factor as excess bleeding was seen in 12.4% of patients with platelet count $\leq$ 50,000 (statistically significant). Hematoma formation was observed among 5.1% cases with platelet count < 50,000 (statistically significant).

Table 6: Excess bleeding was observed in 2.9% patients with normal PT/INR/ PTTK/BT/CT compared to 96.8% with prolonged PT/INR/ PTTK/BT/CT which was statistically significant.

Complications were more common in 7Fr size (57.5%), as compared to 16G size catheters (19.3%).

Maximum number of complications were noted in catheters which were inserted in multiple attempts (77.2%) compared with single attempt (19.2%).

Catheter related blood stream infections (CRBSI): (Table no. 7)

Among 609 catheters inserted, 26 (4.26%) developed catheter-related blood stream infections. Out of these 26 cases, most common organism isolated was Acinetobacter species (42.3%), followed by Methicillin sensitive Staphylococcal aureus (34.6%) and Klebsiella pneumonia (23.07%). Majority of complications occurred in Dialysis catheters, double and triple lumen catheters (84.6%), among which Acinetobacter species was more common while in peripheral single lumen catheters Methcillin sensitive staphylococcus aureus was the most common organism.

Incidence of CRBSI= 84 Events/10,000 Catheter Days. Mean dwell time of the catheter kept in situ was found to be 5.26 days and total number of days catheter kept in situ was 3097 days. There were no deaths related to central venous catheter complications.

IV. Discussion

Central venous catheterization plays an important role in the management of the critical patient and it is an accepted standard practice. However this procedure still has various complications inspite of availability of better technique and material which may occur immediately or may be delayed. The most common indication for central venous catheterization in this study was hemodynamic monitoring (93.9%), followed by volume resuscitation (23.6%) & hemodialysis (10.5%). Study done by Eisenhauer et al showed volume resuscitation and central venous monitoring (73.6%) as the most common indication for insertion[5]. The common site of insertion was the arm veins (68.6%). This is due to ease of insertion at bedside and patient can remain sitting during the procedure in cases of orthopnea. Lower bleeding risk with easy compressibility in cases of arterial puncture is another important factor. In 29.8% of patients internal jugular vein was used, while subclavian vein was cannulated in 1.5%. In a study done by Eisenhauer et.al the most common site of insertion was subclavian vein (51.6%) and internal jugular vein (44.8%) rather than arm veins[5].Catheters were inserted at first attempt in 87% by using external anatomical landmark approach. All catheters were made of polyurethane and were not antibiotic or antiseptic coated.

Complications occurred in 165 (27.09%) patients out of a total of 609 catheterizations. In other studies complications rate has varied between 5% to 19%[6].The most common complication observed in this study was excessive bleeding from the insertion site noted in 46 patients (27.8%). A study done by Eisenhauer et al showed infectious complications as the most common complication (5.2%) [5].Thrombosis was another major complication observed in 20.6% of patients with central venous catheter. The incidence of thrombosis has been

shown to be in the range from 0.3-71%[7].The rate of CVC-induced thrombosis is generally lower for subclavian vein than for IJV and femoral access[8].The rate of thrombosis was reported at 1.9% for subclavian vein(SCV) access[6] and 22% to 29% for femoral[6] access after 4 to 14 days of indwelling time. Study done by Timsit *et al*[9] and Merrer[6] showed that the risk of thrombosis is lowest in the IJV, slightly higher in the SCV and higher still in the FV. Arterial puncture was observed in 13.3% of catheters inserted especially when more than 2 attempts were used. Hematoma formation was seen in 9 catheters sites (5.4%), commonly with multilumen catheter, with multiple attempts and at right internal jugular vein. In one study, 40% of carotid punctures were associated with a hematoma[10].

Catheter related blood stream infection (CRBSI) was observed in 26 (4.26%) patients among 609 catheters inserted. The rate of catheter-related sepsis reported in the literature varies from 4.1%[11] to 39.8%[12] with most reporting a rate around 7%[13] .Out of these 26 cases, most common organism isolated was Acinetobacter species which was isolated with 11 catheters (42.3%), followed by Methicillin sensitive staphylococcus aureus isolated in 9 cases (34.6%) and Klebsiella pneumonia in 6 cases (23.07%). With dialysis catheters, Acinetobacter species was more common while in peripheral catheters Methicillin sensitive staphylococcus aureus was the organism grown. The organisms that cause most catheter related infections are found on the skin, most notably coagulase negative staphylococci[14].

The total number of catheter days was 3097 days, thus catheter related infection rate was 84 events/10,000 catheter days. A study done by Eyer[15] et al showed infection rate of 30-50 events/10,000 catheter days, while study done by Ng PK[16] et al showed infection rate of 6 events/10,000 catheter days. Other studies which showed incidence of approximately 5.3 per 1,000 catheter days[17].

Incorrect catheter tip position was noted in 8 (4.8%) catheters inserted. In one study subclavian route was more prone for misplacement into the ipsilateral internal jugular vein in 15% of patients[18] .Usually there is a lesser opportunity for malposition with jugular than with subclavian access[19] .Leaving misplaced catheters in place for any length of time represents a high risk of thrombosis, catheter fracture/embolism[20]. Pneumothorax was seen in 3 patients (0.5%). An incidence of 1% to 1.5% is consistently reported[19] .Most of the evidence points toward a higher incidence of pneumothorax when the SCV is cannulated, as compared with the IJV[21].In one study SCV catheterization has been linked to a lower incidence of pneumothorax than IJV access[22].Pleural effusion was seen in 2 patients (0.3%). Haemothorax after CVC insertion is mostly an expression of an inadvertent arterial injury, which has been reported to occur approximately in 1% of central catheterizations[13]. Irretrievable guidewire was observed in 2 (1.2%) patients. Damage to neighbouring structures in form of development of right sided Horner's syndrome was noticed in 1 patient (0.6%). Various studies have reported the rates of Horner's syndrome between 0.002% to 2%[23] .Cardiac arrhythmia in form of supraventricular tachycardia was seen in 1 patient which subsided with withdrawal of guidewire.

Excess bleeding (12.4%) and hematoma (5.1%) was associated with low platelet count (<50,000). Deranged coagulation profile (PT/INR/PTTK) was associated with excess bleeding (96.8%). A study done by Fisher et al found only 0.2% incidence of excess bleeding in patients with deranged INR[24].The overall success rate was 72.9% as determined by the ability to use the catheter till completion of intended therapy. There were no deaths related to central venous catheter complications. There was no incidence of needle stick injury in this study.

V. Conclusion

CVC is a safe procedure when performed under strict aseptic precautions and by utilizing standard evidence-based protocols. The platelet count and the coagulation profile of patients should be checked before insertion of CVC. Attempts should be limited to 2 percutaneous punctures, as complications rates are higher with more needle passes. All personnel have to be trained to follow standard protocol of CVC procedure to decrease the complications.

Bibliography

[1]. Eisenberg HD. Culture of intravascular devices. Clinical Microbiology Procedures Handbook, 2004; 2nd edition. Washington DC: ASM Press 13.12.1-6.
[2]. Maki DG, Weise CE, Sarafin HW. A semiquantitative culture method forIdentifyingintravenous-catheter-relatedinfection.NEJM1977; 296:1305-1309.
[3]. Safdar N, Fine JP, Maki DG (2005) Meta-analysis: methods for diagnosingIntravasculardevice-related bloodstream infection. Ann Intern Med 2005; 142:451-466.
[4]. Eisenberg HD. Culture of intravascular devices. Clinical Microbiology ProceduresHandbook, 2004; 2nd edition. Washington DC: ASM Press 13.12.1-6.
[5]. Eisenhauer ED, Derveloy RJ, Hastings PR. Prospective evaluation of centralVenouspressure (CVP) catheters in a large city-county hospital. Ann Surg1982; 196(Nov):560-4.
[6]. Merrer J, De Jonghe B, Lefrant JY, et al. Complications of femoral and subclavian Venous catheterization in critically ill patients. A randomized controlled trial. JAMA 2001; 286:700– 707.
[7]. Wilson GL, McGregor PJ, Thompson GR. Long-term complications of intravascular cannulation. In: Venus B, Mallory DL, eds. Problems in CriticalCare. Philadelphia, Pa: J.B. Lippincott Company; April-June 1988; 2:296-313

[8]. McGee DC, Gould MK. Preventing complications of centralvenous catheterization. N Engl J Med 2003; 348:1123–1133.
[9]. **9)**Timsit JF, Farkas JC, Boyer JM et al. Central vein catheter related thrombosisin intensive care patients.Chest 1998; 114:207–213.
[10]. Denys BG, Uretsky BF, Reddy S. Ultrasound-assisted cannulation of the internal Jugular vein. A prospective comparison tothe external Landmark-Guided Technique. Circulation 1993; 87:1557–1562.
[11]. Dillon JD Jr, Schaffner W, Van Way CW, Meng HC. Septicemia and total parenteral nutrition.JAMA 1973; 223:1341-1344.
[12]. Bernard RW, Stahl WM, Chase RM Jr. Subclavian vein catheterization: a prospective study. II. Infectious complications. Ann Surg 1971; 173:191-200.
[13]. Ryan JA, Abel RM, Abbott WM, et al. Catheter complications in total parenteral nutrition. N EnglJ Med 1974; 290:757-761
[14]. **14)**Padberg FT Jr, Ruggiero J, Blackburn GL, Bistrian BR. Central venous catheteri-zation for parenteral nutrition. Ann Surg 1981; 193:264–70.
[15]. **15)**Eyer S, Brummitt C, Crossley K, et al. Catheter related sepsis: prospective,randomized study of three methods of long-term catheter maintenance.Crit Care Med1989; 18: 1072-1079.
[16]. **16)** Ng PK, Ault MJ, Maldonado LS. Peripherally inserted central catheters in the
[17]. intensive care unit. J Intensive Care Med 1996; 11: 49-54.
[18]. **17)** O'Grady NP, Alexander M, Dellinger EP, et al. Guidelines for the prevention of
[19]. Intravascularcatheter-related infections. Centers for Disease Control and Prevention. MMWR RecommRep 2002; 51(RR-10):1–29.
[20]. **18)** Kidney DD, Nguyen DT, Deutsch LS. Radiologic evaluationand management ofMalfunctioninglong-term central veincatheters. AJR Am J Roentgenol 1998; 171:1251–1257.
[21]. **19)** Ruesch S, Walder B, Tramer MR. Complications of centralvenous catheters: internaljugular versus subclavian access—asystematic review. Crit Care Med 2002; 30:454–460.
[22]. **20)** Aitkin DR, Minton JP. The 'Pinch-off Sign': a warning of impending problemswithpermanentsubclavian catheters. American Journal of Surgery 1984; 148:633–636
[23]. **21)**Eisen LA, Narasimhan M, Berger JS, et al. MechanicalComplications ofCentral Venous Catheters.J Intensive CareMed. 2006; 21:40-46.
[24]. **22)** Miller JA, SingyreddyS,Maldjian P, et al. A reevaluation of the radiographically
[25]. Detectablecomplications of percutaneous venousaccess lines inserted by foursubcutaneousapproaches.AmSurg 1999;65:125–130.
[26]. **23)** Goldfarb G, Lebrec D. Percutaneous cannulation of the internaljugular vein in patients with coagulopathies. An experiencebased on 1,000 attempts. Anesthesiology 1982; 56:321–323.
[27]. **24)** Fisher NC, Mutimer DJ. Central venous cannulation in patients with liver disease and coagulopathy: a prospective audit. Intensive Care Med 1999; 25:5.

Table 1: Age and Sex Distribution

Age groups (Years)	Males	Females	Total
10-20	68	56	124
21-30	92	84	176
31-40	66	43	109
41-50	50	20	70
51-60	38	14	52
61-70	20	18	38
71-80	05	10	15
81-90	04	01	05
Total	343	246	589

Table 2: Indications for Insertion of Catheters

Indications for insertion	No. Of catheters(n= 609)	(%)
Hemodynamic monitoring	572	93.9
Volume resuscitation	144	23.6
Hemodialysis/plasmapheresis	064	10.5
Vasoirritant drugs/incompatible drugs	011	1.8
Lack of peripheral access	004	0.6
Total parenteral nutrition	002	0.3

Table 3: Sites of catheter insertion

Sites	No. %	Left(n=62)	Right(n=547)
		No. %	No. %
Basilic/cephalic vein	41868.6%	40	378
Internal jugular vein	18229.8%	20	162
Subclavian vein	91.4%	2	007
Total	609	62 10.1%	547 89.8%

Table no.: 4 Profile of complication of CVC:

Complications	No. Of complications N=165	%
Excess bleeding	46	27.8
Arterial puncture	22	13.3
Hematoma formation	09	5.4
Incorrect catheter-tip position	08	4.8

Pneumothorax	03	1.8
Pleural effusion	02	1.2
Damage to neighboring structures	01	0.6
Cardiac arrhythmia	01	0.6
Thrombosis	34	20.6
Catheter-related sepsis	26	15.7
Infection at exit site	07	4.2
Mechanical phlebitis	04	2.4
Embolization/fracture/irretrievable catheter/guide wire	02	1.2
Total	165	100

Table no: 5 Relationship of platelet count with excess bleeding and hematoma formation :

Platelet count	**No. of cases**	**Excess bleeding**	
		No.	**%**
<50,000	177	22*	12.4
>50,000	412	24	5.8
Platelet count	**No. of cases**	**Hematoma formation**	
		No.	**%**
<50,000	177	9*	5.1
>50,000	412	-	-

By Chi Square Test = * P < 0.05 Significant

Table No: 6 Relationship of PT/INR/PTTK And Excess Bleeding And Hematoma Formation.

Pt/Inr/Pttk/Bt/Ct	**No. Of Cases**	**Excess Bleeding**	
		No.	**%**
Normal	558	16*	2.9
Prolonged	31	30	96.8
Pt/Inr/Pttk/Bt/Ct	**No. Of Cases**	**Hematoma Formation**	
		No.	**%**
Normal	558	9	1.6
Prolonged	31	-	--

By Chi Square Test * P < 0.05 Significant

Table no: 7 Distribution of organisms causing catheter related biood stream infections (CRBSI)

Organism	**No of catheters**		
	PICCs	**Multi -lumen /Dialysis**	**Total %**
Acinetobacter sp.	1	10	11 42.3
Methicillin sensitive Staphylococcus (MSSA)	2	07	09 34.6
Klebsiella pneumonia	1	05	06 23.0
Total	4 (15.3%)	22 (84.6%)	26

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