Original Article

# Central Venous Catheter Complications in the Poisoning Emergency Center: A 5-Year Cross-Sectional Study

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## Abstract

**Background:** Central venous catheters (CVCs) are used widely in emergency centers, which may be associated with complications. There is a paucity of literature focusing on CVC complications, specifically in the poisoning emergency centers. In this study, we determined the frequency of CVC complications in patients with acute poisoning.

**Materials and Methods:** This was a cross-sectional study performed in the poisoning referral center. We reviewed the medical records of patients with acute poisoning who underwent CVC at the time of admission/during hospitalization in the poisoning intensive care unit or poisoning ward and were hospitalized between 2014 and 2019.

**Results:** During the study period, 33, l37 patients with acute poisoning had been admitted and CVC was placed for 400 patients (1.20% of total patients). Most of the CVCs had been placed via femoral (51%) (204 cases). The frequency of CVC complications was 13.75%. The CVC in the internal jugular (IJ) vein was associated with a higher complication (20.7%) (*P* value 0.02). Infection (9.2%) and pneumothorax (9.2%) were more observed with the IJ approach, while arterial puncture was more observed with subclavian (3.7%) (*P* value < 0.0001).

**Conclusions:** The frequency of CVC placement in acute poisoning patients was not noticeable. Although the femoral vein was the most commonly used approach in our institution, overall complications were more observed with the IJ vein approach.

**Keywords:** Central venous catheter, complications, intensive care unit, poisoning

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## Introduction

Central venous catheters (CVCs) are used widely nowadays and are helpful to treat patients admitted to emergency care units and intensive care units (ICUs) in hospitals.[1,2] By increasing the number of ICU patients, the importance of CVCs is more remarkable.[3] The CVCs are used for a variety of purposes including drug administration, blood sampling from patients, and making transfusions.[4,5] Despite their usefulness, these catheters have some complications including infection, thrombosis, arterial puncture, and pneumothorax.[6,7]

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There are some studies regarding the CVC complications in patients hospitalized in ICU. Henrique and colleagues evaluated adult patients undergoing central venous puncture at the Hospital de Clínicas de Porto Alegre (HCPA) ICU. CVCs were used in 311 patients. The main reasons for the CVC were lack of peripheral access and need for venous access for chemotherapy and severe sepsis/septic shock, and the most common complication was arterial puncture.[3] Infection as a CVC complication has been reported in other studies.[2,8,9] In the study by Hodzic in Bosnia and Herzegovina, arrhythmia,



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arterial puncture, and hematomas at the place of catheter insertion were the common complications in 108 cases.[10] Guillet also reported CVC thrombosis during intravenous antibiotic therapy (1.79%).[7]

Acute poisoning is one of the most common causes of emergency hospital admissions.[11] Drug poisoning has been responsible for 5–10% of emergency interventions.[12] Patients with acute poisoning may present with severe clinical manifestations including coma, hemodynamic instability, hypovolemic shock, and respiratory problems which may cause both morbidities and mortalities.[13] Inadequate access to peripheral veins, especially in substance abusers, administration of medications with a high risk of thrombophlebitis in peripheral veins (as long-term use of hypertonic dextrose in poisoning patients with hypoglycemic drugs), evaluating hemodynamic conditions, determining central venous pressure, and fluid administration, may be the most important reasons for the placement of CVC in patients with acute poisoning.[1] Most studies about CVC-related complications originate from anesthesia, critical care, and trauma settings, and the incidence of complications specifically related to CVC in the poisoning emergency centers has not been documented. Therefore, in this study, we evaluated the CVC complications in patients with acute poisoning hospitalized in ICUs and wards.

## Materials and Methods

This cross-sectional study was conducted by a collaboration of the Surgery and Clinical Toxicology Departments. Populations of the study were patients admitted to the poisoning referral center of Khorshid hospital, affiliated with Isfahan University of Medical Sciences, Isfahan, Iran, from April 2014 to March 2019. Patients with CVCs placed at admission time or during hospitalization were included in the study. Two or more repetitions for catheter placement were exclusion criteria. Data were obtained from a review of the case notes of the physicians and nurses. We included information in the data gathering form. Parameters recorded were as follows: age, gender, level of consciousness, type of poisoning, kind of substance, the reason for the placement of CVC, insertion site of CVC, previous history of the disease, complications of CVC, physicians inserting the CVC, length of hospital stay, and the outcome of the patients (recovered and death). We divided the kind of substances into four groups: illegal substances (opioids, stimulants, and ethanol), pesticides, multi-drugs, and others (pain killers, psychotropics, hypnotics, and other medications).

Site infection was defined as localized inflammation, erythema, and a minimal amount of exudate.[14,15] Systemic infection was defined when the patient had fever and chills and there was no evidence of an alternative source of infection.[16,17] Pneumothorax was diagnosed through control imaging by chest X-ray after inserting of CVC.[18] In this study, the indication for catheter replacement was based on the presence of fever without pulmonary and urinary origin and other causes and the presence of signs of local catheter infection (such as hot erythema at the catheter entrance), and after catheter replacement, the culture was sent from the catheter tip. Our common method to reduce the risk of infection at the surgical site was using povidone–iodine (PVI), using sterile gloves, and maintaining sterility during the procedure.

Statistical analyses were conducted using SPSS software version 15 (SPSS Inc., Chicago, USA). Fisher exact or Chi-square test, independent T-Test, and analysis of variance (ANOVA) were used for comparisons of different variables. Data are presented as mean (SD) or standard error (SE) and number (percent) where applicable. A *P* value less than 0.05 was considered as a significant difference.

## Results

During the study period, 33,137 patients with acute poisoning had been admitted. CVC was inserted for the 416 patients. Sixteen patients were excluded from the study because of exclusion criteria (two repetitions for catheter placement). Therefore, the data regarding the 400 patients were evaluated (1.20% of total patients). The mean age (SD) of the patients was 43.92 (17.38) years (minimum, 12; maximum, 90). Most of the patients were men (77%) and married (72.3%). The type of exposure in 59.3% of patients was attempting suicide. Illegal substance poisoning (48.1%) was the most type of poisoning. Characteristics of the patients are shown in Table 1.

CVCs have been inserted for the patients without using ultrasonic or fluoroscopic guidance. After placing the CVC, 92.25% patients were admitted to ICU, and 7.75% of patients stayed in the ward (369 CVCs were inserted in the ICU). The most common reason for the placement of CVC was inadequate peripheral vein access (93.5%), hemodynamic evaluation (4.3%), and drug administering/fluid therapy (2.3%). None of our patients received total parenteral nutrition (TPN), and their nutrition supplement was through a nasogastric tube. CVC had been placed in femoral veins in 51% of the patients. On the left side, CVC placement was more in the subclavian (SC) vein, while on the right side, CVC placement was more in the femoral vein. Infection and pneumothorax (9.2%) were more observed with internal jugular (IJ), while arterial puncture was more common with SC (3.7%) (*P* value < 0.0001). Five patients had more than one complication of CVC. Arrhythmia and thrombosis were not reported. A comparison of different variables with respect to the site of CVC is shown in Table 2.

The rate of CVC complications was 13.75%. The IJ approach was associated with a higher overall complication rate (20.7%) than the SC (16.5%) and femoral (9.3%) (*P* value = 0.02). CVC in the left side had more complications (22%), compared to right side (11.3%) (*P* value = 0.01) [Table 3].

A comparison of different CVC complications with respect to different variables is shown in Table 4. There was a significant

**Table 1: Toxico-clinical characteristics of the patients with acute poisoning underwent CVC**

| Parameters | Number (%) |
|---|---|
| Gender | |
| Men | 308 (77%) |
| Women | 92 (23%) |
| Type of exposures | |
| Suicide | 237 (59.30%) |
| Drug abuse | 95 (23.8%) |
| Accidental | 28 (7%) |
| Unknown | 40 (9.9%) |
| Route of exposures | |
| Ingestion | 362 (90.5%) |
| Inhalation | 7 (1.75%) |
| Injection | 9 (2.25%) |
| Unknown | 22 (5.5%) |
| Toxic agents | |
| Illegal substances | 192 (48.1%) |
| Pesticides | 55 (13.8%) |
| Multi-drug | 62 (15.5%) |
| Others | 91 (22.6%) |
| History of previous disease | |
| Cardiovascular | 91 (22.7%) |
| Diabetes | 24 (6%) |
| Renal failure | 22 (5.5%) |
| Pulmonary | 28 (7%) |
| Psychiatrics | 19 (4.8%) |
| Without previous disease | 216 (54%) |
| Level of consciousness | |
| Alert | 162 (40.5) |
| Lethargic/obtundation | 58 (14.5) |
| Stupor | 90 (22.5) |
| Coma | 90 (22.5) |

CVC=Central venous catheter, the results are presented as number (percent)

relationship between kind of complication, indication, and side of CVC placement.

There was no significant relationship between complications of CVC and type of poisoning, past history of previous disease, and clinical manifestations of poisoning including abnormal blood pressure, low level of consciousness, and respiratory problems ($P > 0.05$). Forty-four patients survived without any poisoning complication. 111 (27.8%) patients died (51.4% poisoning with illegal substances, 25.2% pesticide poisoning, 4.5% multi-drug poisoning, and 18.9% other poisoning). 245 (61.25%) patients found complications of poisoning including aspiration pneumonia, renal failure, and liver toxicity. Among those patients with acute poisoning who died (111 case), 13 cases also had CVC complications.

## Discussion

We reviewed the complications of CVC in patients with acute poisoning hospitalized in poisoning ICUs/wards. The CVC is an essential tool to administer intravenous therapy in patients with acute poisoning. However, it can be affected by complications that may necessitate longer hospitalization and increasing health costs. The results showed most of the patients with acute poisoning were male and young, similar to other studies.[19,20]

The main reason for poisoning was suicide (59.3%), which was less than that in other studies.[21] In our study, the most placement of CVC was in the femoral vein, while in the Eisen study, the subclavian vein was the most.[22] The preference of the physician in charge for inserting CVC may have affected it.

The overall frequency of complications of CVC was less compared to other studies in non-poisoning cases hospitalized in trauma and critical care services. The rate of CVC infection in our study was 6.25% compared to 14.8% in Bozzetti study on patients with home parenteral nutrition (HPN), 26.5% in a study by Shirotani and colleagues on patients on HPN, and 24% in Van Rooden study in patients undergoing intensive chemotherapy hospitalized in hematology wards.[2,23,24] CVC complications occur frequently during TPN management, and recent studies have shown that for patients using a CVC, parenteral nutrition is a significant and independent risk factor for CVC-related infections.[2,23] However, none of the patients in our study received TPN.

CVC was inserted in most cases because of inadequate access to peripheral veins. Most of the patients were young and without underlying disease compared to other patients hospitalized in ICU because of trauma, internal diseases, and cancer. CVC-related infections can be reduced by adopting best-practice procedures and checking their implementation over time.[25-27]

Yamamoto *et al*.[28] found that the use of 1% chlorhexidine gluconate ethanol for the skin disinfectant of the CVC exit site in adult patients with long-term CVCs was associated with infections of 0.75 per 1000 CVC-days, and the disinfection effect of chlorhexidine–alcohol may be better than that of povidone–iodine (PVI) that we used.[29-31]

Our results showed that the rate of pneumothorax was 4.25%, which was higher than those reported in other centers.[19,32] Lack of using ultrasound or fluoroscopic guidance may be the reason. Also, we could not exclude a pneumothorax that may have been present before the CVC since all patients did not have chest X-rays prior to inserting the CVC. Further study is required to clarify this issue.

The arterial puncture occurred in 2% of our patients, while in the Odendaal study on trauma patients, it was 1.37%; in the Comerlato study, it was 3.9%; and in the Rey study in the pediatric ICU, it was 7.2%.[3,6,33] An arterial puncture may occur when the catheter insertion is performed using the blind landmark method.

In our study, subclavian placement had more arterial complication. However, in Ruesch's study, the arterial complication of IJ placement was more than subclavian.[34] The IJ approach was associated with significantly higher overall complication rates. This may reflect the relative experience

**Table 2: Comparison of the catheterization site with respect to different variables**

| Variables | Catheterization site | | | Total | *P |
|---|---|---|---|---|---|
| | Internal Jugular (*n*=87) | Femoral (*n*=204) | Subclavian (*n*=109) | | |
| Gender | | | | | |
| Men, *n* (%) | 69 (22.5%) | 150 (48.7%) | 89 (28.8%) | 308 (73%) | 0.22 |
| Women, *n* (%) | 18 (19. 6%) | 54 (58.7%) | 20 (21.7%) | 92 (23%) | |
| Age; Mean (SD) (Minimum-maximum), year | 43.52 (16.28) (13–90) | 43.29 (17.65) (12–88) | 45.42 (17.82) (15–88) | 43.92 (17.38) (12-90) | 0.57 |
| Indication for CVC, *n* (%) | | | | | 0.03 |
| Inadequate peripheral veins access | 83 (95.4%) | 184 (90.2%) | 107 (98.2%) | 374 (93.5%) | |
| Drug Administering/Fluid therapy | 0 (0%) | 8 (3.9%) | 1 (0.9%) | 9 (2.3%) | |
| Hemodynamic evaluation | 4 (4.6%) | 12 (5.9%) | 1 (0.9%) | 17 (4.3%) | |
| CVC insertion operator, *n* (%) | | | | | 0.000 |
| Surgeon/surgery resident | 41 (47.1%) | 89 (43.6%) | 85 (78%) | 215 (53.7%) | |
| Emergency Medicine specialist | 5 (5.8%) | 34 (16.7%) | 2 (1.8%) | 41 (10.3%) | |
| Anesthesiologist | 41 (47.1%) | 81 (39.7%) | 22 (20.2%) | 144 (36%) | |
| Side of Catheter, *n* (%) | | | | | 0.000 |
| Right | 63 (72.4%) | 175 (85.8%) | 71 (65.1%) | 309 (77.3%) | |
| Left | 24 (27.6%) | 29 (14.2%) | 38 (34.9%) | 91 (23.7%) | |
| Complications of CVC, *n* (%) | | | | | 0.000 |
| Infection | 8 (9.2%) | 12 (5.9%) | 5 (4.6%) | 25 (6.3%) | |
| Pneumothorax | 8 (9.2%) | 0 (0%) | 9 (8.3%) | 17 (4.3%) | |
| Arterial puncture | 0 (0%) | 4 (2%) | 4 (3.7%) | 8 (2%) | |
| More than one complication η | 2 (2.3%) | 3 (1.5%) | 0 (0%) | 5 (1.2) | |
| Without complication | 69 (79.3%) | 185 (90.6%) | 91 (83.4%) | 345 (86.2%) | |

CVC=Central venous catheter; the results are presented as number (%); *Chi-square/Fisher exact test or ANOVA where applicable. η More than one complication refers to patients who had two of these complications (infection, pneumothorax and arterial puncture). $P<0.05$ was considered statistically significant

**Table 3: Comparison of different variables between patients with and without CVC Complications**

| Variables | Patients without complications of CVC (*n*=345) | Patients with complications of CVC (*n*=55) | P* |
|---|---|---|---|
| Age (year), Mean (SD), (Minimum-maximum) | 44.11 (17.24) (12-90) | 42.69 (18.39) (15-88) | 0.57 |
| Male, *n* (%) | 267 (86.7) | 41 (13.3) | 0.60 |
| Indication for CVC, *n* (%) | | | |
| Inadequate peripheral vein access | 332 (86.1) | 52 (13.9) | 0.57 |
| Drug Administering/Fluid therapy | 9 (100) | 0 (0) | |
| Hemodynamic evaluation | 14 (82.4) | 3 (17.6) | |
| CVC insertion operator, *n* (%) | | | |
| Surgeon/surgery resident | 182 (84.7) | 33 (15.3) | 0.60 |
| Emergency Medicine specialist | 37 (90.2) | 4 (9.8) | |
| Anesthesiologist | 126 (87.5) | 18 (12.5) | |
| Catheterization site, *n* (%) | | | |
| Right | 274 (88.7) | 35 (11.3) | 0.01 |
| Left | 71 (78) | 20 (22) | |
| Catheterization site, *n* (%) | | | |
| Internal Jugular | 69 (79.3) | 18 (20.7) | 0.02 |
| Femoral | 185 (90.7) | 19 (9.3) | |
| Subclavian | 91 (83.5) | 18 (16.5) | |
| Time from admission to inserting CVC; mean (SD); (Minimum-maximum) hours | 96.5 (128.34) (2 – 1224) | 148.32 (172.11) (6-820) | 0.009 |
| Length of hospital stay (hours); mean (SD); (Minimum-maximum) | 387.41 (338.19) (6 – 2184) | 1014.36 (902.46) (144-4704) | 0.000 |

CVC=Central venous catheter; SD=Standard deviation; *Comparison between patients with and without complications; Data analyzed by Chi-square/Fisher exact test or independent *t*-test where applicable. $P<0.05$ was considered statistically significant

of the physician as the femoral approach was much more commonly performed in the poisoning emergency setting. Also, the lack of using ultrasound guidance for inserting CVC may be the other important factor. Brass *et al*.[35] demonstrated

**Table 4: Comparison of different types of CVC complications**

| Variables | Infection | Pneumothorax | Arterial puncture | More than one complication | *P |
|---|---|---|---|---|---|
| Gender, *n* (%) | | | | | 0.73 |
| Men | 18 (43.9%) | 14 (34.1%) | 5 (12.2%) | 4 (9.8%) | |
| Women | 7 (50%) | 3 (21.4%) | 3 (21.4%) | 1 (7.2%) | |
| Age, mean (SD) (Minimum-maximum), year | 41.12 (19.21) (19–88) | 44.69 (16.22) (15–70) | 47.5 (20.88) (24–77) | 36.4 (19.68) (20–68) | 0.69 |
| Indication for CVC, *n* (%) | | | | | 0.02 |
| Inadequate peripheral vein access | 24 (46.2%) | 17 (32.7%) | 8 (15.3%) | 3 (5.8%) | |
| Drug Administering/Fluid therapy | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | |
| Hemodynamic evaluation | 1 (33.3%) | 0 (0%) | 0 (0%) | 2 (66.7%) | |
| CVC insertion operator, *n* (%) | | | | | 0.32 |
| Surgeon/surgery resident | 12 (36.4%) | 12 (36.4%) | 6 (18.1%) | 3 (9.1%) | |
| Emergency Medicine | 2 (50%) | 0 (0%) | 1 (25%) | 1 (25%) | |
| Anesthesiologist | 11 (61%) | 5 (27.8%) | 1 (5.6%) | 1 (5.6%) | |
| Catheterization site, *n* (%) | | | | | 0.35 |
| Right | 15 (42.9%) | 11 (31.4%) | 7 (20%) | 2 (5.7%) | |
| Left | 10 (50%) | 6 (30%) | 1 (5%) | 3 (15%) | |
| Time from admission until inserting the CVC (hours); mean (SE); (minimum-maximum) | 170.16 (182.24) (6–768) | 148.47 (177.96) (48–820) | 108.75 (173.02) (6–528) | 102 (113.04) (6–288) | 0.76 |
| Length of hospital stay (hours); mean (SE); (Minimum-maximum) | 1456.88 (1106.27) (168–4704) | 546.35 (239.62) (144–912) | 513 (277.2) (240–1032) | 1195.2 (767.7) (168–2160) | 0.002 |

CVC=Central venous catheter; *Chi-square/Fisher exact test, or ANOVA where applicable; SE, Standard error; $P<0.05$ was considered statistically significant

in a Cochrane review that ultrasound guidance reduced the complication rate for the IJ vein approach. There was a heterogeneous group of physicians in our institution who may have different levels of training and experience. Some CVC has been inserted by surgery residents, and the varying levels of supervision may have contributed to the higher complication rates. Finally, arrhythmia and thrombosis were not recorded in our patients, although they have been reported in other studies.[7,10,36]

Our results showed 27.8% of patients died and most of them were poisoning with illegal substances and pesticides. We cannot justify whether the CVC was also a risk factor for their death. As we had evaluated only patients with acute poisoning who underwent CVC, we could not perform regression analysis to find whether CVC was a mortality risk factor. However, another study has reported that death of the patients has been associated with many factors including CVC for dialysis access.[37] In a multi-national, multi-center, prospective cohort study performed by Rosenthal *et al*.,[38] to identify all-cause mortality risk factors in ICU patients, in Latin American, Asian, African, Middle Eastern, and European countries, central line-associated bloodstream infection was one of the important mortality risk factor. A reduction in CVC complications is always a priority for physicians. Using pre-mature techniques for CVC insertion can compromise patient safety with some complications. Therefore, to properly perform CVC, several clinical guidelines have been developed.[39]

We did not evaluate the treatment approach to the CVC complications, which may be a limitation of the study. Some CVCs remove because of systemic and site infections. Bacteremia may be life-threatening for the patient, and it is always associated with an increased health cost and prolongation of the hospital stay. Another limitation of our study was the population we evaluated, which included just poisoned patients. We recommend that future studies focus on comparison of the complications of CVCs in poisoned versus non-poisoned patients. Also, this study was a retrospective study provided by one department. Therefore, the results may only be applicable to all poisoning ICUs. Despite these limitations, this study was the first to evaluate the CVC complications in the poisoning cases in our society. We hope that the findings of the present study will help physicians responsible for CVC to better understand the need for preventing CVC-related fatal complications.

## Conclusions

The use of CVC carried some complications, and infection was the most complication. Although the femoral vein was the most commonly used approach in our institution, overall complications were more observed with the IJ vein approach.

We believe that using ultrasound (US)[40] or fluoroscopic guidance, implementation of the procedure-specific protocol, and supervision of training physicians may reduce the complication rates. A large multi-center study investigating the optimal US protocol is needed. It is also suggested to set up more educational programs to improve CVC standard care.

### *Ethics approval and consent to participate*

This research has been performed in accordance with the Declaration of Helsinki and has been approved by the ethics

committee of Isfahan University of Medical Sciences (Ethics code: IR.MUI.MED.REC.1399.211).


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### Conflicts of interest

There are no conflicts of interest.

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