

# Complications Involving Central Venous Catheter Insertion in Newborns Admitted to the Neonatal Intensive Care Unit (NICU)

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## Abstract

**Background:** Developments in the use of central venous catheters have improved the treatment of critically ill newborns.

**Objectives:** The aim of this retrospective study was to evaluate the rate of catheter-related complications and associated risk factors in newborns.

**Patients and Methods:** This cross sectional study evaluated 60 infants with indications for central venous catheters who were selected by census from 2007 to 2014 in Baqiyatallah Hospital in Tehran, Iran. The catheters were Broviac numbers 14 - 16.

**Results:** Ultimately, 60 cases (17 males and 43 females) with a mean age of  $26.25 \pm 20.09$  days (Min = 1 day and Max = 153 days) underwent analysis. The most common reasons for venous catheter placement (98.3%) were prolonged hospitalization and lack of peripheral vessels. The most common complication was catheter-related infection, which occurred in 20 patients (33.3%). Death occurred in 24 patients (40.0%), but only 3 deaths (5%) were due to complications from the central venous catheter. A significant relationship was evident between infection and catheterization duration ( $P = 0.02$ ).

**Conclusions:** Most of the catheter-related deaths were due to severe sepsis and hemothorax, and a significant relationship was noted between infection and both the mortality rate and catheterization duration. A significant relationship was also evident between birth weight and infection rates.

**Keywords:** Catheter, Complication, Newborn

## 1. Background

The treatment of critically ill newborns has improved with developments in the use of central venous catheters (CVCs) (1, 2), which allow rapid and reliable vascular access for the administration of fluids and medications. However, previous studies indicate that the use of these catheters is associated with a high rate of life-threatening complications (3-7). The rate of complications is reduced by the participation of trained medical and nursing staff and by the presence of sufficient structure to ensure safe placement and maintenance of the CVC (8, 9).

## 2. Objectives

The aim of this retrospective study was to evaluate the rate of catheter-related complications and associated risk factors following insertion of CVCs in newborns in the

neonatal intensive care unit (NICU). Our hospital is one of the referral hospitals with a large number of patients and no similar study has been reported previously.

## 3. Patients and Methods

### 3.1. Patients

After receiving ethics approval and patient informed consent for this cross sectional study, 60 infants with indications for central venous catheters were selected by census from the patients admitted to Baqiyatallah hospital in Tehran, Iran, between 2007 and 2014. The catheters were Broviac catheters numbers 14 - 16. We considered catheter placement as an inclusion criterion. We excluded any patient whose file was incomplete.

### 3.2. Catheter Placement

Percutaneous placement ( $n = 60$ ) was performed in the intensive care unit by the anesthesiologist, in most cases under light general anesthesia, as described by Shaw. Briefly, after sterile dressing and skin disinfection, the micro-catheter was introduced into a peripheral or proximal vein and advanced to the right atrium through a 1 gauge butterfly needle, which was then removed. The extracorporeal edge of the catheter was connected to the infusion line via a blunt-end needle. The technique was modified for polyurethane (PU) catheters, where the puncture needle is visible and the distal edge of the catheter is sealed to the connecting tube; this reduces the risk of perforation of the catheter by the connecting needle. The catheter tip was radiographically monitored for adequate positioning after injection of 2 mL of Hexabrix (Lab Guerbet, France). The catheter was then secured with either sterile glue and a Steri-Strip (3M San@ France) or a clear, sterile, moisture permeable adhesive film (Op-Site) placed over the insertion site.

### 3.3. Complications

Our recorded complications included bleeding, cellulitis, sepsis, catheter thrombosis, leakage of fluid from the skin, and accidental catheter exit. The data collected were body weight, catheterization duration, and site of catheter entry, which included the internal jugular vein, superior vena cava, and femoral vein. We used the patient files to collect information about complications. All data were collected by a neonatologist with 10 years of experience.

Data were analyzed using the Statistical Package for Social Sciences (SPSS) software, version 16 (SPSS Inc. Chicago, IL) for Windows and the Chi square test and Student t-test. A  $p$  value of less than 0.05 was considered statistically significant.

## 4. Results

Ultimately, 60 cases (17 males and 43 females), with a mean age of  $26.25 \pm 20.09$  days (Min = 1 day and Max = 153 days), underwent analysis. The patients had an average weight of  $1731 \pm 910.57$  g (Min = 590 g and Max = 3,800 g). The mean gestational age was  $31.23 \pm 4.51$  weeks (Min = 20 weeks and Max = 40 weeks). The mean duration of catheterization was  $15.13 \pm 10.02$  days (Min = 1 day and Max = 39 days).

Table 1 shows the infant classifications based on weight. More babies (30%) had a birth weight of 1000 -1500 g when compared to the other classes.

The most common reasons for venous catheter placement (98.3%) were prolonged hospitalization and lack of

peripheral vessels. A central venous catheter was inserted in one patient (0.7%) due to hypoglycemia.

### 4.1. Complications of Central Venous Catheter

Overall, 32 infants (54%) experienced complications following the insertions. Table 2 shows the complications encountered with the central venous catheter.

In 30 (50.0%), 28 (46.7%), and 2 (3.3%) patients, the catheter was inserted once, twice, and more than twice, respectively. The central venous catheter was inserted into the internal jugular vein in 56 patients (93.3%), into the superior vena cava in 2 patients (3.3%), and into the femoral vein in 2 patients (3.3%).

As shown in Table 2, 20 patients (33.3%) experienced catheter-related infection. Of these 20 cases, 15 (75%) had positive blood cultures: 12 patients (60.0%) were positive for *Candida*, and 3 patients (15.0%) were positive for *Klebsiella*. In 8 patients (40.0%) with positive urine cultures, *Candida albicans*, *Klebsiella*, and *Enterococcus* were reported in 4, 1, and 3 patients, respectively. *Candida albicans* was reported in all 3 cases where positive cultures were obtained from the catheter insertion site. Based on the total days of catheterization (908 days), the prevalence of infection was estimated at about 22 in 1,000 days. Table 3 shows the distribution of the 20 cases with infection after catheterization.

Death occurred in 24 patients (40.0%), but only 3 (5%) of these cases died due to complications from the central venous catheter. Two of these 3 patients died due to catheter site infection and severe sepsis, and the other died due to a catheter-related hemothorax.

### 4.2. The Relationship Between Birth Weight and Infection Rates, Death Rates and Catheterization Duration

Table 4 shows the distribution of the prevalence of infection and death, based on weight groups. A significant difference was found between the groups.

### 4.3. The Relationship Between Infection Rates and Death Rates, Catheterization Duration, and Catheter Insertion Site

Of the 24 infants who died, 13 patients (54.2%) had infections, and two cases of infection were due to the catheter. A significant difference was noted between death and sepsis ( $P = 0.03$ ).

A significant relationship was found between infection and the catheterization duration ( $P = 0.02$ ).

Of the 56 cases with an internal jugular vein catheter, infection occurred in 18 cases (32%). No infection occurred in the cases with superior vena cava or femoral vein catheters. These differences were not statistically significant ( $P = 0.3$ ).

**Table 1.** Infant Classifications Based on Birth Weight

Birth weight, g	Frequency (%)
< 1000	15 (25)
1000 - 1500	18 (30)
1500 - 2500	12 (20)
> 2500	15 (25)
Total	60 (100)

**Table 2.** Catheter Complications

Complications	Frequency (%)
Bleeding	6 (10)
Fluid leak	6 (10)
Accidental catheter exit	5 (8.3)
Catheter obstruction	6 (10)
Infection	20 (33.3)

**Table 3.** Distribution of Infection Related to Catheterization

Cases	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BC	C	-	C	C	C	C	K	-	C	-	C	K	C	-	C	C	C	K	-	C
UC	C	C	-	-	-	-	E	K	-	C	-	-	-	E	-	-	-	E	C	-
CC	C	-	C	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Death	+	+	+	+	-	+	-	-	-	+	+	-	+	+	+	-	+	-	+	+
CD/day	17	31	8	16	4	5	28	25	15	36	39	25	10	19	8	4	5	28	36	39

Abbreviations: BC, blood culture; UC, urine culture; CC, catheter insertion site culture; CD, catheterization duration; C, *Candida albicans*; K, *Klebsiella*; E, *Enterococcus*.

**Table 4.** Distribution of Infection and Death Based on Birth Weight<sup>a</sup>

Birth weight, g	Infection	Death
< 1000	8	9
1000 - 1500	6	6
1500 - 2500	0	1
> 2500	6	8
Total	20	24
P value	0.02	0.03

<sup>a</sup>No significant relationship was found between birth weight and catheterization ( $P = 0.77$ ).

#### 4.4. The Relationship Between Death Rates and Catheterization Duration, Catheter Site, and Positive Blood Culture

No significant differences were found between infant mortality rates and catheterization duration ( $P = 0.8$ ).

An internal jugular vein catheter was placed in 56 cases, and death occurred in 21 of these cases (37.5%). Neither of the two cases with a catheter placed in the superior vena cava vein died. Death occurred in one of the two cases

(50%) with a femoral vein catheter. These differences were not statistically significant ( $P = 0.1$ ).

## 5. Discussion

The most common complication resulting from catheter insertion was infection (33%), with bleeding, leakage, and catheter obstruction next in rank. The prevalence

of infection was estimated at about 22 in 1,000 days. The mortality rate due to catheter insertion was 5%, and most deaths were due to severe sepsis, with hemothorax next in frequency. A significant relationship was found between infection and both mortality rate and catheterization duration. A significant relationship was also evident between birth weight and infection rates ( $P = 0.01$ ).

The limitations of this study included incomplete file data in some cases and the inability to obtain an accurate determination of all the factors affecting the incidence of complications.

Goutail-Flaud et al. (10) reported an incidence of complications of central venous catheters of 28%, with the most common complications being accidental catheter exit (11.6%), followed by perforation or obstruction of the catheter. The rate of infection was reported as 4%. Murai et al. (11) found a rate of infection of about 2.3%, while Khairi et al. (12) reported an infection rate of 14%. These values were much lower than those in the present study and may reflect differences in catheter care.

Goutail-Flaud et al. (10) reported a low mortality rate of 0.3%, which can be explained by differences in available facilities. Hosseinpour et al. (13) reported a mortality rate of 9.5%, which was not significantly different from the mortality rates reported in different studies conducted in Iran.

Murai et al. (11) showed a significant correlation between infant weight and infection rates, in agreement with our findings. Darouiche et al. (14) reported an incidence of catheter-related infections of 7 cases in 1,000 days, which was lower than the incidence in our study.

In conclusion, the occurrence of catheter-related infections that can lead to neonatal mortality emphasizes the importance of maintaining proper care of catheters in infants. Further studies with larger sample sizes are recommended to confirm the results of the present study.

## Footnote

**Authors' Contribution:** All authors contributed equally to this project.

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