

Review Paper: Complications of Central Venous Catheter Insertion in Patients Undergoing Hemodialysis in Iran



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ABSTRACT

Background: Regarding the prevalence of chronic renal disease and CVC (central venous catheterization) complications, this systematic review and meta-analysis was performed to determine the prevalence of CVC complications in Iran.

Methods: In this systematic review and meta-analysis, based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, all Iran and international databases from 2000 to 2019 were investigated using keywords of fever during or after dialysis, redness of the catheter insertion site, swelling, tenderness (touch sensitivity), infection, thrombosis, inadequate catheter (catheter malfunction), hemothorax, and pus outflow (pus drainage). The search was conducted by two members of the research team (MB, AT). In case of any disagreement between them, the quality of the investigation was examined by the third person (AB). In the present study, we analyzed data using comprehensive meta-analysis software.

Results: According to this study's findings, 12 articles with a total sample of 1395 patients were included in the systematic review and meta-analysis. Our findings were as follows: the prevalence of hemodialysis infection was 26.6% (95%CI: 16.2%–40.6%) (I²=95.5, P<0.001, Q=236.66), the prevalence of thrombosis was 18.3% (95%CI: 11.2%–28.6%), and the prevalence of inadequate catheter (catheter malfunction) was 16.1% (95%CI: 9.2%–26.7%).

Conclusion: The prevalence of CVC complications was significant in hemodialysis patients. Therefore, appropriate interventions should be provided to reduce these complications.

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1. Background

All over the world, approximately 10% of the global population, and more than 2 million people suffer from Chronic Kidney Disease (CKD) [1, 2]. In CKD patients, the kidneys cannot maintain the metabolic state and fluid and electrolyte balance [3]. Hemodialysis is one way to manage this chronic disease [4-6]. Although hemodialysis prolongs the life of CKD patients, it has numerous physical and psychological complications [7]. These problems include decreased quality of life and life expectancy, and issues such as stress, anxiety, and depression [8-10].

There are various ways to access the vessels of patients for their hemodialysis. One of these methods is using the Central Venous Catheter (CVC) [11]. CVC has various complications for patients that may even end the patient's life [12]. These complications include infection, thrombosis, fever and chills, pus outflow, tenderness, hemothorax, pneumothorax, catheter dysfunction, and allergy [13-15].

Infection is one of the most acute side effects of CVC that can cause various problems for the patient and the healthcare system. Thus, mortality and hospitalization and treatment costs related to CVC infection are among the most critical issues associated with its use [16, 17]. Blood Stream Infection (BSI) has been identified as the second leading cause of death in CKD patients [18, 19].

Thrombosis is another complication of CVC insertion. In a study on 51049 samples, thrombosis with a prevalence of 1.81% has reported as a second important complication after a port insertion [20]. In a Smitherman study on a pediatric group, the thrombosis prevalence was 3.2% [21], which is a very notable number. Other complications were hemothorax and pneumothorax, with a prevalence rate of 1.5% to 6% (which depends on the surgeon's experience) [22].

Given the prevalence of CKD and the role of CVC complications in endangering patients' health, this SR/Mas (Systematic review and meta-analysis) study was performed to determine the prevalence of CVC complications in Iran.

2. Materials and Methods

Study protocol

This research is an SR/Mas study (Figure 1) based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist [23].

Literature-search strategy

We searched Google Scholar search engine and all of Iran's internal databases such as SID, Regional Information Center for Science and Technology (RICeST), Magiran, Irandoc, Barakat knowledge network system, Iranian National Library, and international databases such as PubMed, Medline International Cochrane Library, Scopus, Science Direct, Web of Sciences, Embase, and EBSCO.

The keywords for searching included central venous catheter, catheter, hemodialysis, chronic renal failure, dialysis, complications, infection, fever during dialysis or after dialysis, catheter insertion redness, swelling, tenderness, infection, thrombosis, catheter malfunction, hemothorax, pus outflow, and allergy using the AND, OR, NOT search strategy. It should be noted that the Persian equivalent of these keywords were also searched. The search was conducted by two members of the research team (MB, AT), and in case of any disagreement between them, the quality of the investigation was investigated by the third person (AB). An example of a search strategy on PubMed is attached.

The Inclusion and Extraction Criteria

The inclusion criteria

All articles investigating the complications of CVC (fever during dialysis or post dialysis, catheter insertion redness, swelling, tenderness, infection, thrombosis, catheter malfunction, hemothorax, and pus outflow, hemothorax and allergy) among Iranian hemodialysis patients were included in the study.

The exclusion criteria

Duplicate studies, case reports studies, SR/Mas, qualitative studies, the studies that data were not reported were excluded.

Data extraction and outcome measures

To extract the data, we formed a checklist, including author's name, year of publication, place, the number of study participants, mean age, fever during dialysis or post dialysis, redness of catheter insertion, swelling, tenderness, infection, thrombosis, catheter malfunction, hemothorax, and the pus outflow.

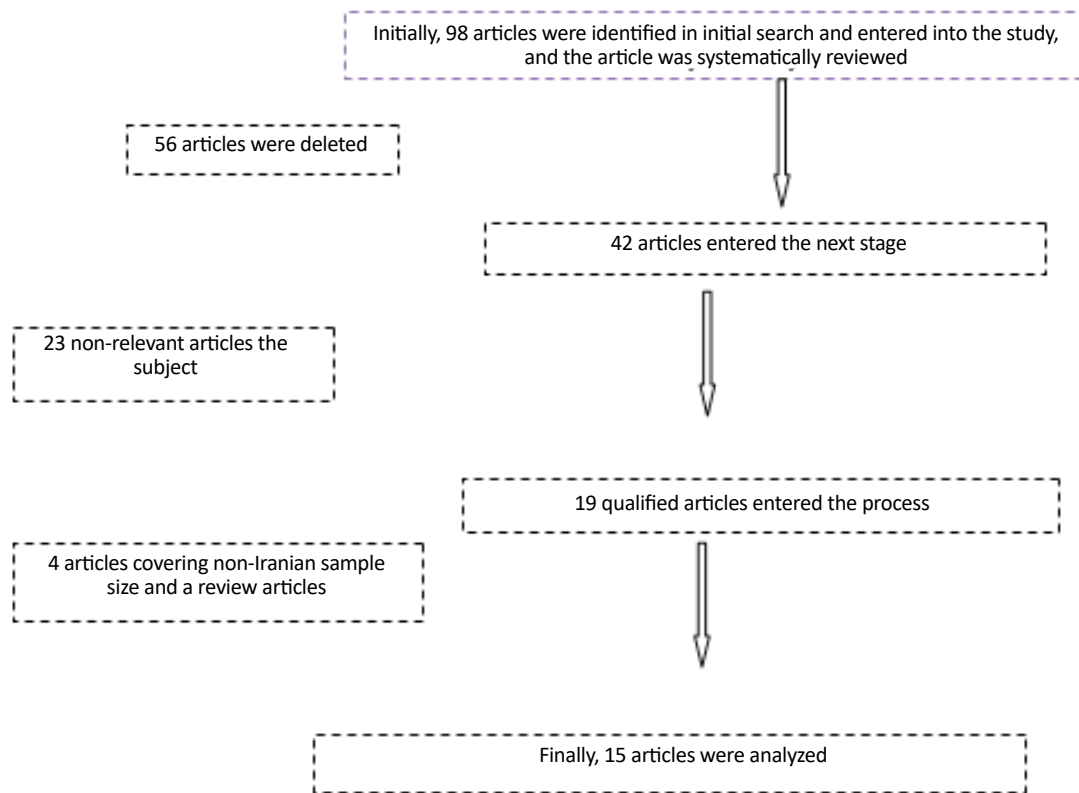


Figure 1. Flowchart for systematic review and meta-analyses

Quality assessment and statistical analysis

In the present study, we analyzed data using comprehensive meta-analysis software. For evaluating the heterogeneity of CVC complications, Cochran's Q test and I² were used. The diversities of the studies were in three sections: less than 25% (low heterogeneity), 25%–75% (moderate heterogeneity), and more than 75% (high heterogeneity). Regarding studying heterogeneity (I² = 94.88, Q = 430.02 m, P < 0.001), we have applied DerSimonian and Laird's random-effects model for combining the studies. Also, we used Kendall's tau in Begg and Mazumdar test and Funnel plot (Figure 2) to examine publication bias.

3. Results

Table 1 presents the findings from the articles entered into the systematic review and meta-analysis. Of 2000 found articles, 12 articles were entered into the systematic review and meta-analysis phase. The total sample size was 1395 patients, extracted from these articles. Twelve studies evaluated infection, 5 studies thrombosis, 5 studies catheter malfunction, 3 studies hemothorax, 3 studies fever, 2 studies catheter erythema, 2 stud-

ies stiffness, 2 studies touch sensitivity, and 2 studies pus drainage.

According to the findings, the prevalence of infection during the dialysis was 26.6% (95% CI: 16.2%–40.6%), (I²=95.5, P<0.001 Q=236.66) (Figure 3); the prevalence of fever during dialysis was 61.8% (95%CI: 11.5%–95.2%) (Figure 4); the prevalence of catheter erythema was 37.5% (95%CI: 31.5%–43.8%) (Figure 5); the prevalence of stiffness was 42.8% (95%CI: 13.1%–78.8%) (Figure 6); the allergy prevalence was 49.9% (95% CI: 6.2%–93.7%) (Figure 7); thrombosis prevalence was 18.3% (95% CI: 11.2%–28.6%) (Figure 8); catheter malfunction prevalence was 16.1% (95%CI: 9.2%–26.7%) (Figure 9); hemothorax prevalence was 0.9% (95% CI: 0.3%–3.1%) (Figure 10) and pus drainage prevalence was 21.5% (95% CI: 2.2%–76.7%) (Figure 11).

4. Discussion

The present study is the first systematic review and meta-analyses of CVC-related complications in Iran, which will be discussed compared to other studies.

The prevalence of central venous catheter-related infection was 26.6% (95% CI: 16.2%–40.6%). In a re-

Table 1. Articles entered into the systematic review and meta-analysis phase

No.	Author (y)	City in Iran	N	Mean±SD	No. (%)								
					Fever	Catheter Erythema	Stiffness	Touch Sensitivity	Infection	Thrombosis	Catheter Malfunction	Hemothorax	Pus Drainage
1	Hemati (2018) [13]	Gilan	170		77.4	32(38.1)	21(25)	17 (20.2)	84 (49.4)	-	-	-	6 (7.1)
2	Sanaei (2012) [14]	Mashahd	65	54.9±15.83	-	35(53.8)	41(63.1)	52(80)	41(63.1)	-	-	-	32(49.2)
3	Afshar (2015) [24]	Kashan	43	65.88±14.27	-	-	-	-	11(25.56)	10(23.2)	1(2.3)	0(0)	-
4	Ghane (2006) [25]	Mashahd	54	-	-	-	-	-	26(48.1)	-	4(7.4)	1(1.8)	-
5	Adib-hajbagheri (2014) [26]	Isfahan	38	-	2 (5.3)	-	-	-	5(13.2)	-	7(18.4)	-	-
6	Beigi (2012) [27]	Isfahan	243	-	-	-	-	-	34(14)	18(7.40)	47(19.3)	1(0.4)	-
7	Samani (2015) [28]	Qazvin	220	58.5±12	-	-	-	-	12(5.4)	-	-	-	-
8	Sepas (2019) [29]	Tehran	145	-	-	-	-	-	24(16.5)	30(20.7)	-	-	-
9	Soleymanian (2017) [30]	Tehran	111	-	-	-	-	-	11(10)	-	-	-	-
10	Sanavi (2007) [31]	Tehran	116	49.5±16	-	-	-	-	78(67)	-	-	-	-
11	Zafarhandi (2013) [32]	-	40	-	-	-	-	-	8(20)	8(20)	13(32.5)	-	-
12	Shahmoradi (2013) [33]	Tehran	150	56.2±15	-	-	-	-	58(33)	40(27)	-	-	-

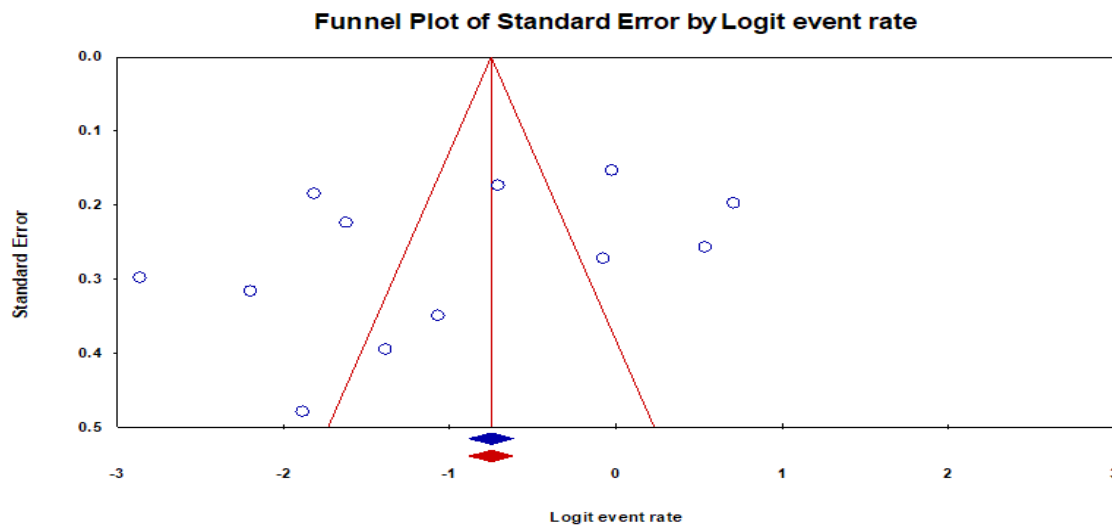


Figure 2. Funnel plot

Z=1.16, P=0.243.

view study by Dreesen et al. on 39 studies in the group of home parenteral nutrition patients, the prevalence rate of central venous catheter-related infections was between 0.38 and 4.58 per 1000; more than half of these infections were Gram-positive bacteria [34]. Also, in the meta-analysis study by Ramritu et al., 3 studies were reviewed; the rate of infection in jugular access was 8.6% and in subclavian access was 2.24% [35]. The Zhang et al. cohort study showed that in Italian hemodialysis patients, the prevalence of CR blood stream infection was 0.84 for each 1000 catheter-day [36]. Silva et al. on the hemodialysis patients showed that the CRI rate was 0.6 to 6.5 per 1000 [37].

According to the findings, the prevalence of thrombosis was 18.3% (95%CI: 11.2%–28.6%), and the prevalence of catheter malfunction was 16.1% (95%CI: 9.2%–26.7%). Östlund et al. showed that the incidence rate for CVC-related Venous Thrombosis (VT) was 29.6 per 1000 [38]. Also, in the study of Hughes et al. on hemodialysis patients in Nigeria, the dislodging rate was 6 (5.5%), and the low flow rate was 9 (8.3%) [39].

5. Conclusion

The prevalence of CVC complications was significant in hemodialysis patients. Therefore, appropriate interventions should be considered to reduce these compli-

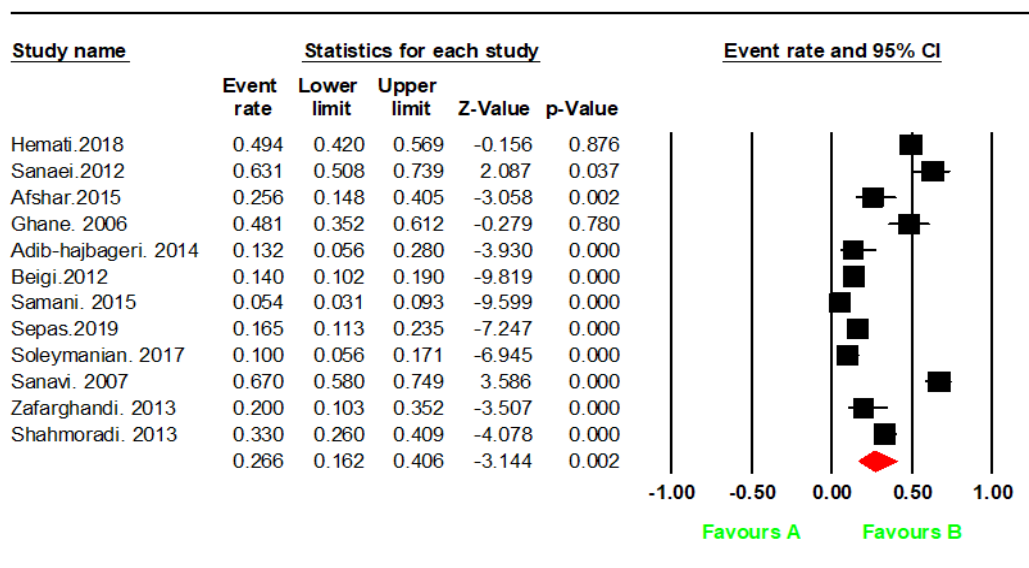
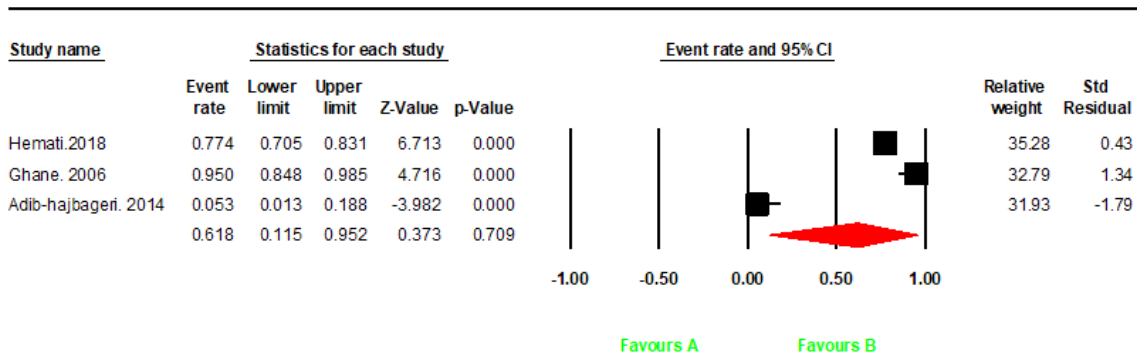
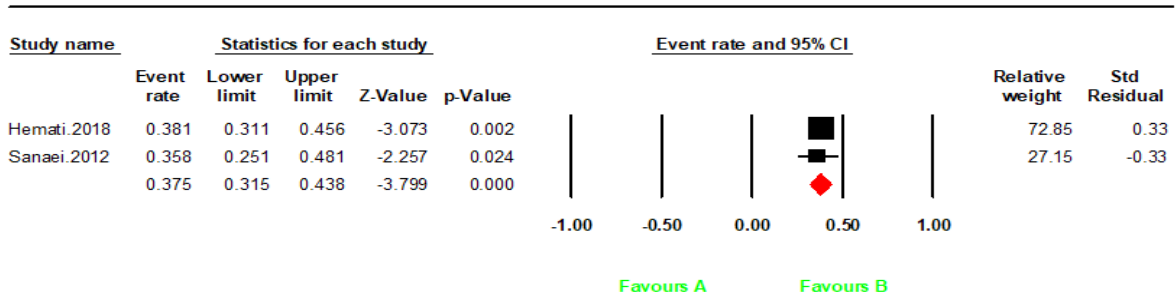


Figure 3. Prevalence of infection



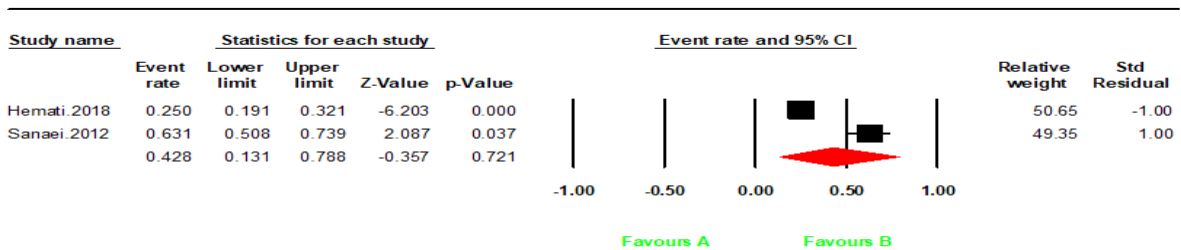
Meta Analysis

Figure 4. Prevalence of fever during dialysis



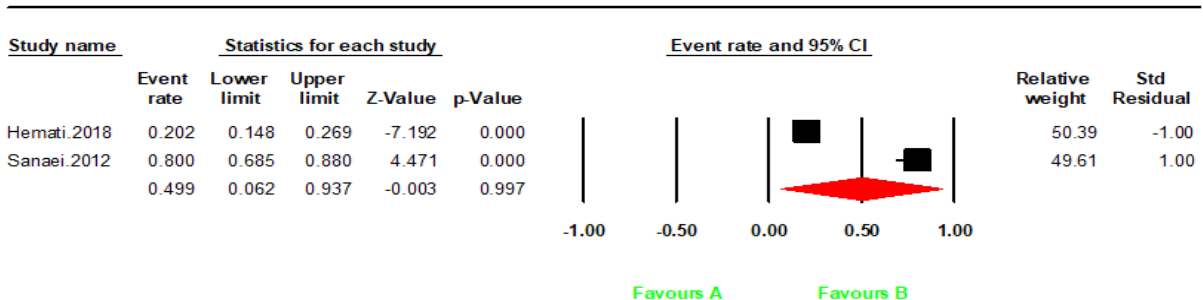
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Figure 5. Prevalence of catheter erythema



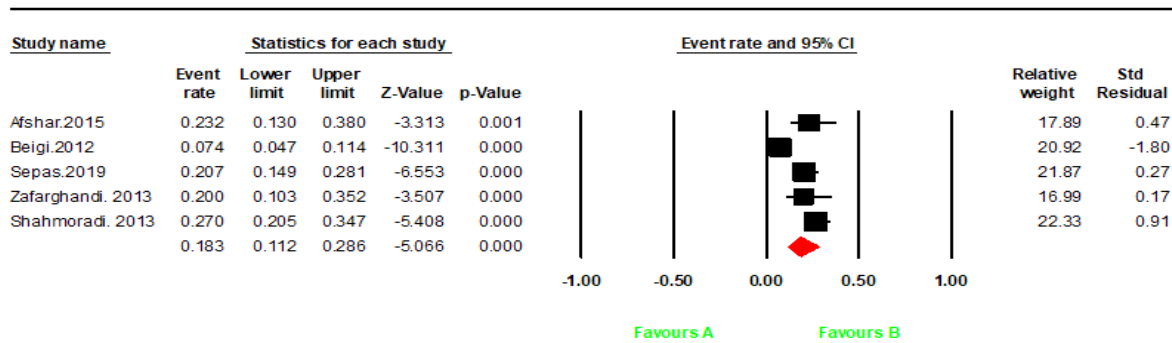
Meta Analysis

Figure 6. Prevalence of stiffness



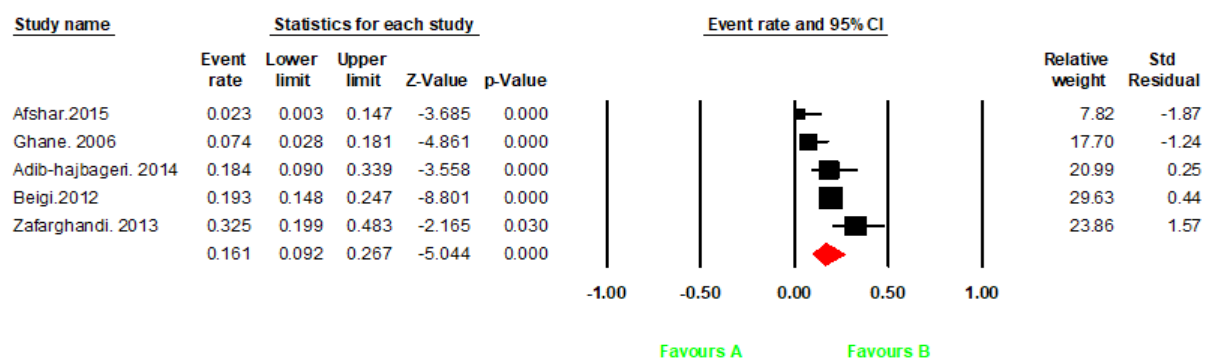
Meta Analysis

Figure 7. Prevalence of touch sensitivity



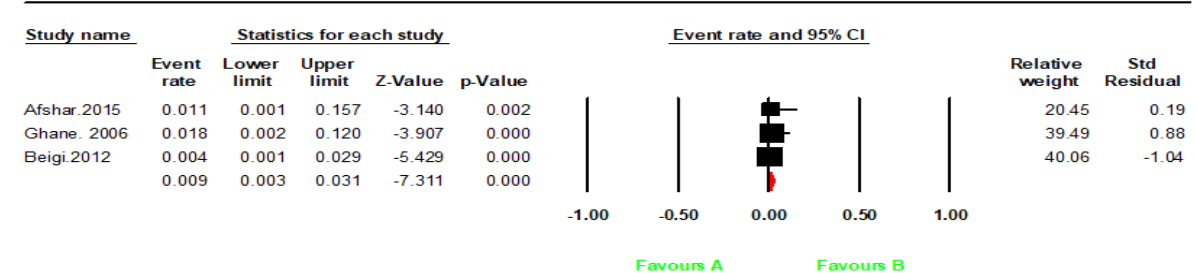
Meta Analysis

Figure 8. Prevalence of thrombosis



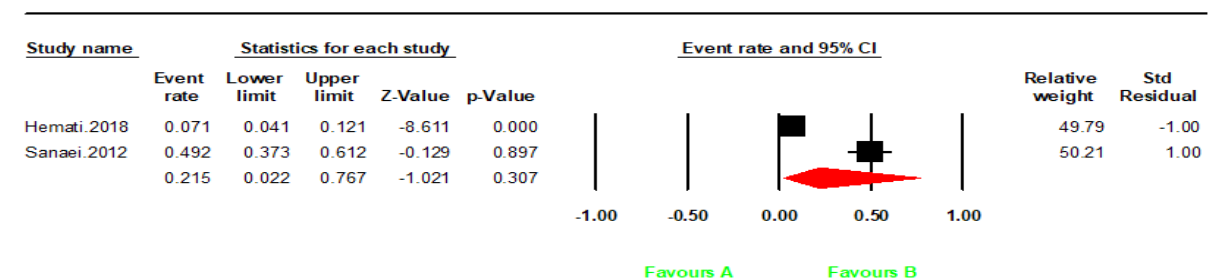
Meta Analysis

Figure 9. Prevalence of catheter malfunction



Meta Analysis

Figure 10. Prevalence of hemothorax



Meta Analysis

Figure 11. Prevalence of pus drainage

cations. The essential CVC complication is infection. The role of the healthcare providers is very notifiable for improving this situation by patient's education and by encouraging them to do self-care behaviors.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Research Ethics Committee of Kermanshah University of Medical Sciences (Kums.REC.1398.920).

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Author's contributions

Methodology: Mohamad Karimian, Ali Gholami, and Milad Borji; Mohamad Karimian; Data collection: Atieh Okhli; Data analysis: Asma Tarjoman, Mohamad Karimian, Milad Borji, Somayeh Mahdikhani, Writing – original draft, and Writing – review & editing: Mohamad Karimian; Final approved: All authors.

Conflict of interest

The authors declared no conflict of interest.

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