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Determining Intravenous Complications in Patients with Infusion Pumps

İnfüzyon pompası ile izlenen hastalarda intravenöz komplikasyonların belirlenmesi

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Original Research

Abstract

Objective: Intravenous infusion complications are placing patients at high risk and creating an economic burden for hospitals and health institutions. Available infusion pumps provide to decrease complications and patient safety. However, life-threatening complications may occur in patients with infusion pumps. This study was performed to determine of incidence of intravenous complications and influencing factors in patients with infusion pumps.
Method: The study utilized causal model comparison and cross sectional design and was carried out with 120 patients monitored with infusion pump in a single university hospital in Turkey. Independent variables such as patients' demographic data, catheter type, catheter site, intravenous infusion type, infusion duration, and total infusion volume in patients with infusion pump that influencing complications were investigated in this study.
Results: Intravenous infusion complications developed in 10% of patients in present study. Thrombophlebitis (6.7%) was the most frequent complication. The study did not reveal any significant difference between the patient's age, gender, number of comorbidities and incidence of intravenous infusion complications ($p>0.05$). Statistically significant differences were found between the catheter site, infusion duration, total infusion volume and incidence of intravenous infusion complications ($p<0.05$). Complication rates were higher in patients administered with prednol®, dormicum®, dopamine®, norepinephrine® and antibiotics.
Conclusion: Thrombophlebitis rate (6.7%) in patients with infusion pump was similar to literature (2.5-60%). As for total infusion complication rate was 10%. The study revealed that patients who had femoral vein catheterization, longer infusion time, received prednol®, dormicum®, dopamine®, norepinephrine® and antibiotics and more than 2000 ml infusion solution per day are at high risk for infusion complications.

Keywords: Intravenous, infusion pump, risk factor, complication, nurse

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Öz

Amaç: İntravenöz infüzyon komplikasyonları hastaları yüksek risk altında bırakarak, hastaneler ve sağlık kuruluşları için ekonomik yük oluşturmaktadır. Mevcut infüzyon pompaları, komplikasyonları azaltmakta ve hasta güvenliğini sağlamaktadır. Buna rağmen, infüzyon pompası ile takip edilen hastalarda sağlığı tehdit edici komplikasyonlar gelişebilmektedir. Bu araştırma infüzyon pompası ile izlenen hastalarda gelişen komplikasyon sıklığını ve etkileyen faktörleri belirlemek amacıyla yapılmıştır.
Yöntem: Nedensel karşılaştırma modeli ve kesitsel tasarımın kullanıldığı bu araştırma, Türkiye'de bulunan bir üniversite hastanesinde, infüzyon pompası ile izlenen 120 hastayla gerçekleştirilmiştir. Çalışmada infüzyon pompası ile izlenen hastaların demografik verileri, kateter tipi, katater bölgesi, intravenöz infüzyon tipi, infüzyon süresi ve toplam infüzyon hacmi gibi bağımsız değişkenlerin infüzyon komplikasyonu gelişme sıklığına etkisi incelenmiştir.
Bulgular: Araştırmada hastaların %10`unda infüzyon komplikasyonu gelişmiştir. Tromboflebit (%6,7) en sık gelişen komplikasyon olmuştur. Hastaların yaşı, cinsiyeti, eşlik eden komorbid hastalık sayısı ile intravenöz infüzyon komplikasyon sıklığı arasında istatistiksel açıdan anlamlı bir fark bulunmamıştır ($p>0,05$). Kateter bölgesi, infüzyon süresi, total infüzyon hacmi ile intravenoz infüzyon komplikasyonu arasında anlamlı bir fark olduğu belirlenmiştir ($p<0,05$). Ayrıca, prednol®, dormicum®, dopamin®, norepinefrin® ve antibiyotik uygulanan hastalarda komplikasyon sıklığının daha yüksek olduğu bulunmuştur.
Sonuç: İnfüzyon pompası ile takip edilen hastalarda literatüre benzer oranlarda (%2,5-60) tromboflebit (%6,7) gelişmiştir. Ayrıca, femoral ven kateteri olan, uzun süre infüzyon alan, prednol®, dormicum®, dopamin®, norepinefrin® ve antibiyotik uygulanan ve günde 2000 ml'den daha fazla infüzyon solüsyonu alan hastaların komplikasyon açısından daha yüksek risk altında oldukları belirlenmiştir.

Anahtar Kelimeler: İntravenöz, infüzyon pompa, risk faktör, komplikasyon, hemşire

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Introduction

Infusion pumps are medical devices connected to central/peripheral venous catheters with intravenous lines for delivering targeted dose and volume of liquid/medicine/nutrition solution to patients practically and safety in specified time.[1-3, 30-34.] Nurses can administer intravenous treatments confidently and with minimal complications through software programs and sensors in intravenous infusion pump.[1, 2] Rate of using infusion pump in clinics have increased in recent years, but intravenous therapy-related complications are still important that causing prolonged hospitalization, workload and serious costs. [30-34.] Nurses have primary responsibility of using intravenous infusion pumps in clinics and administering infusion liquids to patients without developing any complications.[4] Although close monitoring, some complications such as infiltration, thrombophlebitis, fluid overload, bleeding, air embolism, infections may develop in patients with who receiving intravenous infusions.[3,5-7, 33, 34.] Intravenous treatment complications are stated that related in patient's conditions such as vascular structure, age, gender, health problems and other conditions including catheter type, catheter insertion site, catheter dwell time, amount of treatment, and nurse's knowledge, skill and education.[8-10]

There are numerous publications including intravenous infusion complications, risk factor of thrombophlebitis, medical errors, and nurses' responsibilities in infusion treatments in the literature.[6, 11-15] However, there has been no published research that examining descriptive and intravenous treatment characteristics of patients monitoring with infusion pump and investigating the relationship between these conditions and incidence of intravenous infusion complications. The study may

contribute to nurses for planning their interventions and updating knowledge about on infusion monitoring by determining infusion complications and influencing factors in patients with infusion pumps. This study aimed to identify intravenous infusion complications and influencing factors in patients with intravenous infusion pumps.

Method

Research design and sample

The study utilized causal model comparison and cross sectional methodology to assess the incidence of intravenous infusion complications and influencing factors in patients with infusion pumps. Study was carried out in internal medicine clinics of a university hospital that located in Ankara. Neurology, neurology intensive care, internal medicine and internal medicine intensive care clinics were chosen due to high patient capacity and using intravenous infusion pumps routinely. These clinics had totally 200 patient bed capacity and 50 clinical nurses were working, and standard infusion pumps including cassette mechanism, capable of two different intravenous infusions simultaneously, automatic drug calculation programming features were utilized for all patients. The study population comprised of all the patients admitted in internal medicine clinics between August 2012 and January 2013, all the peripheral and central venous catheter inserted to patients and, had received intravenous therapy with an infusion pump during at least one day. According to pilot study results the study sample was computed by using "NCSS-PASS 2007" program and 120 patients enrolled in the study with 10% error, 95% confidence interval and 80% power. Convenience sampling technique was used and eligible patients hospitalized in internal medicine clinics were selected. Patients included in the study were 18 years old and older; had full consciousness and orientation; did not have any communication problems; received intravenous treatments with a standard infusion pump at least one day. Patients under 18 years and younger, communication problems were excluded from the study.

Data collection procedures

Instruments

The data of the patients' were collected by using "Data collection form for patients with infusion pumps". The form was developed by researchers based on related literature.[1, 5, 9, 16, 17] The validity of the data collection form was established by consultation with the experts from the field of nursing. A pilot study was conducted to assess the feasibility of the study and relevant modifications were made. First part of data collection form included 6 questions that queries patients' descriptive characteristics such as gender, age, comorbid disease, staying in intensive care or clinic, the reason for hospitalization, the time of hospitalization, second part of data collection form containing 7 questions related intravenous infusions including infusion type, infusion duration, infusion indication, total volume of infusion solutions, catheter type, catheter site and status of infusion complication. Data collection was done after ethical approval from the Medical, Surgical and Pharmaceutical Ethics Committee of the University. Eligible patients admitted to clinics were enrolled. An informed written consent was obtained from each patient. If the infusion pump was present, patients were assessed by the researchers for infusion complications and the data was filled up by face to face interviews with patients and reviewing the fluid and treatment records of the patient. However, if it was absent, the

date, time and reason for not using the infusion pump were documented and follow-up was terminated.

Data analysis

Descriptive statistics were reported as frequencies, means and standard deviations. Chi-square or Student t tests were used for socio-demographic and individuals characteristics (age, gender, co-morbid disease, catheterization time, number of infusion pump, amount of intravenous liquid) to determine the relationship between patients with and without infusion complications. All statistical analysis was performed using SPSS software package, for a level of significance of 0,05.

Results

Patients' demographic and intravenous treatment characteristics

The mean age of the 120 patients enrolled in the study was 59.5 ± 17.4 years with the range between 18-89 years. More than half of the patients (55.8%) were males in the study. The great majority of patients (80.2%) with intravenous complications and more than half of the patients (57.1%) without infusion complication had multiple chronic diseases (Table 2). Comorbidities included such as hypertension, diabetes mellitus, coronary artery disease, cerebrovascular diseases, chronic renal failure and chronic heart failure and hyperlipidemia, etc.

Intravenous infusion complications were occurred in 10% of patients in the present study. These intravenous infusion complications were thrombophlebitis (6.7%), extravasation (2.5%), and infiltration (0.8%) respectively. The causes of intravenous infusion complications included inappropriate position of patient (41.6%), prolonged catheter duration (25%), large amounts of infusion fluid (16.7%), and edematous skin (16.7%) (Table 1).

Table 1. Distribution of intravenous infusion complications (n=120)

Complication status	n	%
Complication present	12	10.0
Thrombophlebitis	8	6.7
Extravasation	3	2.5
Infiltration	1	0.8
Complication not present	108	90.0
Total	120	100
Causes of infusion complications		
Inappropriate position of patient	5	41.6
Prolonged catheter duration	3	25.0
Excessive fluid therapy	2	16.7
Edematous skin	2	16.7
Total	12	100

Influencing factors of infusion complications in patients with infusion pumps

There was no statistical significant difference with patients' age, gender, number of comorbidities and incidence of infusion complications. The most commonly used catheters were peripheral catheters in patients with infusion complications (92.3%) and central venous catheters (17.2%) for patients without infusion complications and there was no significant difference between catheter type and

incidence of intravenous infusion complication. Intravenous catheters were inserted in upper-extremity veins (60.2%), particularly femoral (21.1%) and jugular veins (18.5%) respectively. Infusion complication rate was statistically significantly higher in patients with catheters inserted in femoral vein compared to upper-extremity veins. Continuous infusion type (100%) was used for patients who had infusion complications in present study. There was no statistically significant difference between incidence of infusion complications and intravenous infusion type (Table 2).

Table 2. Patients' demographics and infusion characteristics and frequency of infusion complications (n=120)

		Complication status				**Test statistic**	**P value**
		Not present		**Present**			
		n	**%**	**n**	**%**		
Age(59.5+/-17.4) (Range:18-89 y)		61.9	-	47.6	-	Z=-1.356	0.175
Gender	Female	49	92.5	4	7.5	X^2=0.240	0.624
	Male	59	88.1	8	11.9		
Number of comorbid diseases	1-3	8	57.1	85	80.2	X^2=3.532	0.167
	4+	6	42.9	21	19.8		
Catheter type	Peripheral venous catheter	84	92.3	7	7.7	X^2=2.228	0.159
	Central venous catheter	24	82.8	5	17.2		
***Catheter site**	Upper-extremities	149	92.0	13	8.0	X^2=12.756	**0.002**
	Femoral	42	73.7	15	26.3		
	Jugular	42	82.4	8	17.6		
	Total	233	86.3	36	13.7		
Infusion type	Continuous	100	93.0	12	100	X^2=0.952	0.417
	Intermittent	7	6.2	0	0.0		
	Bolus	1	0.8	0	0.0		

** Patients had multiple catheters.*

Regarding infusion time, the mean infusion duration was calculated as 72 ±7.7 days for patients with infusion complications, and 3.7±5.1 days for patients without infusion complications in the study. Intravenous infusion complication frequency was found higher in patients who have longer infusion time. The difference between incidence of intravenous infusion complications and infusion duration was statistically significant. Similarly, the average of intravenous solutions was computed 2276.8±824.0 ml/day in patients with infusion complications and, 1504.1±797.6 ml/day in patients without infusion complications. There was a statistically difference between the amount of solutions and infusion complication frequency (Table 3).

Table 3. Infusion time, infusion volume and frequency of infusion complications (n=120)

Infusion day and volume	Complication status		Test statistic	P value
	Not present (n=108)	*Present (n=12)*		
Time of infusion (day) (X±SD)	3.7±5.1	7.2±7.7	Z= -2.889	**0.004**
Total infusion volume (ml/ per day) (X±SD)	1504.1 ±797.6	2276.8 ±824.0	Z= -2.892	**0.004**

This study examined also a statistical difference between medications and intravenous complication frequency. Prednol® (33%), dormicum® (28,6%), dopamine® (22.2%), norepinephrine® (22.2%) and antibiotics (12.5%) were also increased the infusion complications when compared to other medications (Table 4).

Table 4. Medication types and frequency of infusion complications

Medication types	Complication frequency (%)
Prednol®	33.0
Dormicum®	28.6
Dopamine®	28.6
Norepinephrine®	22.2
Antibiotics®	12.5

Discussion

Intravenous infusion-related complications can lead to many problems, including higher cost of treatment, prolonged hospitalization and increased nurse's workload.[4, 14] The purpose of this study was to determine the incidence of infusion complication rate and influencing factors in patients with infusion pumps.

Thrombophlebitis complication rate was found as 6.7% in patients with infusion pumps in this study. In general, thrombophlebitis rate is reported between 2.3% and 60% among patients who receiving intravenous treatments.[13, 18] However, to the best of our knowledge, there has been no study indicating complication rate in patients with infusion pumps. There have been few reports publishing complication causes associated with infusion pumps including failure to comply with standard IV (intravenous) drug dilutions; inappropriate use of the IV bolus technique, use of potent IV medications, and overriding drug rate limits. [28, 29.] Varying rates of thrombophlebitis in wide range can be attributed to infusion pump technical properties, patients' records and nurses' knowledge and skills in using infusion pumps.

Previous studies have shown various risk factors related intravenous infusion complications containing demographic features of patients (age, gender, vascular structure), nursing interventions (hand-technique, having experience, attention to sterility, following the catheters, infusion sets, infusion pumps, etc. regularly), pharmacological procedures (drug irritation, infusion rate).[6, 7, 13, 15, 20] In

recent studies, Nassaji-Zavareh and Ghorbani (2007), showed that female gender as a predisposing factor whereas Kaur, Thakur (2011) considered that male gender as a risk factor for development intravenous infusion complications. Another reports specified that gender was not a risk factor for infusion complications (Cornely and Bethe, 2002; Uslusoy and Mete, 2008). Consistent with these reports, we did not find a statistically significant difference between incidence of infusion complications and patients' gender ($p>0.05$). As for age, Cicolini, Bonghi (2009) indicated that patients aged between 31-60 years had low infusion complication rates and Kaur, Thakur (2011) reported patients under 60 years were more susceptible for intravenous infusion complications. Patients' mean age was 59.5±17.4 years in current study but no difference were defined between patients' age and infusion complications in present study. Similarly, no significant difference between the number of comorbidities and infusion complication frequency. However, we have no sufficient clarification for these differences in the studies. A possible reason for these differences, can be attributed to studies sample characteristics, patients' records and using a standard infusion pump for all patients in this study.

Veins used during intravenous infusion are considered as a determinant factor in infusion complication incidence.[4, 6] Previous studies showed that femoral vein catheterization is more related to increase the rate of infection, thrombosis and other intravenous complications. Aygun (2008) stated the incidence of central venous catheter infections are firstly related in femoral vein. More complication developed in femoral vein of patients in the present study similarly to the literature.

Previous studies reported that the long duration of catheterization significantly increases the rate of thrombophlebitis and other infusion complications.[5, 23, 24] Tagalakis, Kahn (2002) said that duration of catheterization is the most important predictor factor of peripheral vein infusion thrombophlebitis. Myles, Buckland (1991) stated that when peripheral vascular catheter held in 72 hours or later time, the sepsis risk increases 2-5%. We similarly found a statistically significant difference between incidence of infusion complications and the mean duration of infusion. Infusion complications were statistically significantly higher in patients with longer infusion time compared to shorter infusion time ($p<0,05$). We assumed that multiple interventions, contaminated lines, nursing care procedures and prolonged catheter duration could be effective in increasing the frequency of infusion complications. Up to now, there has been no study examining the impact of infusion pumps on infusion complication rate, so we could not compare our study findings with previous reports. Further studies in patients with infusion pumps are warranted to clarify findings of the study.

Literature reported that administration more than 2000 ml of intravenous fluid to the patients in a day, causes continuous and minor trauma in endothelium of vein, and increases the intravenous infusion complication incidence.[7, 10, 24] Similar to the literature, we found infusion complications were statistically higher in patients received >2000 ml infusion liquid/day compared to <2000 ml infusion liquid/day (Table 3).

The medication types administering to patients affect the probability of infusion complications [7, 10, 13]. This study examined also a statistical difference between medications-infusion solutions and intravenous complication frequency. Prednol® (33 %), dormicum® (28.6 %), dopamine® (22.2%), and antibiotics (12.5%) were also increased the infusion complications when compared to other medications diluted with isotonic solution (x^2=16.480, p=0.019). And norepinephrine® (28.6%) complication rate was higher than the other medications diluted with dextrose solution. The study showed that statistically significant differences were observed between administered medications-

solution type and intravenous infusion complication rate. Furtado (2011) reported that potassium chloride leaded to infusion complications, Regueiro, Souto (2005) and Salgueiro-Oliveira, Parreira (2012) stated that antibiotics increased the complication risk. Considering these results, infusion complication frequency for medications-solutions were comparable to that of the previous reports.

Study limitations

This study limited with internal medicine clinics which infusion pumps were commonly and routinely used, 120 patients and five-month period. Until now, there has been no study investigating infusion complication rate specifically to patients with infusion pumps, we could not compare our study findings with the relevant literature and could not to make a clear inference about the infusion complications.

Conclusion

Continues infusion type and peripheral venous catheters were used for mostly of patients. Upper extremity veins were utilized for catheterization by a large majority. At the end of study, 10% of patients had an infusion complication. Thrombophlebitis was the most frequent complication. This study revealed that patients' age, gender and comorbid conditions did not show a significant effect on infusion complication frequency. However, patients receiving prednol®, dormicum®, dopamine®, norepinephrine® and antibiotics treatments and more than 2000 ml infusion solution per day, had longer infusion time and femoral vein catheterization were at high risk for infusion complications.

The findings from this study will be valuable to nurses to know risk factors and prevent infusion complications in the clinics. A standard care protocol can be developed by the nurses based on the findings of the present study to reduce infusion complications in patients with infusion pumps. Study findings are limited with this study sample and further studies are warranted to provide new data compare the infusion complication rate between the patients with monitoring an infusion pump and patients who receiving intravenous treatments without an infusion pump and clarify these findings.

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Contribution of Authors

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