Comparison of infection of injectable serum solutions administered by upper and lower air bleeding in patients hospitalized in surgical wards

Gholamreza Shabanian (1)
Alireza Shabanian (2)
Amirreza Shekofteh (3)
Mohammadreza Shabanian (4)

(1) Assistant Professor, Department of Anesthesia, Shahrekord University of Medical Sciences, Shahrekord, Iran.
(2) Dentistry student, Isfahan University of Medical Sciences, Isfahan, Iran.
(3) Medical Student, Student Research Committee, Shahrekord University of Medical Sciences, Shahrekord, Iran.
(4) Dentistry student, Isfahan University of Medical Sciences, Isfahan, Iran

Corresponding author:
Mohammadreza Shabanian,
Dental College, Isfahan University of Medical Sciences, Iran.
Tel: +989381936964,
Email: shabanian.mohammadreza@gmail.com

Abstract

Background and Aim: Because hospital infections are one of the major causes of increasing the length of hospital stay, increasing the cost of treatment and mortality and morbidity in patients hospitalized in different wards of the hospital, especially the surgical wards, this study was conducted to determine the prevalence of infection due to injectable serums administered by the two methods upper and lower air bleeding.

Materials and Methods: This descriptive-analytical study was conducted in 2014 at Kashani Hospital in Shahrekord, southwest of Iran. The microbial samples of 250 serums attached to patients hospitalized in different wards of the hospital were collected and were cultured in vitro. Data for serum characteristics, serum bleeding method, and patient's characteristics were collected by a checklist and analyzed by the SPSS version 22.

Results: There was a significant association between the average time interval between serum attachment and sample collection in positive and negative culture samples, and the frequency distribution of microbial culture results with respect to time interval ($P < 0.001$).

The result of microbial culture was negative in 247 cases (98.8%) and positive in 3 cases (1.2%). The bacteria grown in the culture medium were Acinetobacter in 1 case (0.4%), fungus in 1 case (0.4%), and Staphylococcus epidermidis in 1 case (0.4%). There was no significant difference in the culture result in terms of bleeding method ($P=0.59$).

Conclusion: Bleeding of injectable serum due to air pollution in hospital wards has contributed to the infection of these serums, and although the serum bleeding method did not differ in the number of cases of infection development, the number of infection development was higher for the serums administered by lower bleeding.

Key words: Infection; Injection; Serum; Hospitalization; Patients.

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Introduction

Injections are one of the most common methods in prescribing drugs and pharmaceutical derivatives. Obviously, in the case of non-compliance with the therapeutic standards, it creates many dangers such as infection in health care service users (1).

Infection of the skin and soft tissues are some of these infections (2, 3), ranging from Staphylococcal infection to dangerous infections such as HIV and hepatitis B and C (4-8). Injection infections, in addition to causing illness in hospitals highly frequently, impose high hospital and medical costs (9), which require health care personnel and nurses to adopt preventive strategies (10).

Bacteria and other airborne objects in the hospital may enter the serum solution during infusion and infect the contents of the serum. In addition to the factors contributing to the contamination of the serum, such as personnel's hands, contamination of the infusion site, contamination of the secondary equipment such as infusion set and vein set and the primary contamination of the fluid, the contents of the serum can be contaminated during bleeding and the airborne bacteria may enter the solution through a pore that has been created to let the air enter (11).

Hence, considering this issue important, not only leads to saving so many lives, but also affects the health of the community (12). Therefore, it is very necessary to find preventive methods to deal with this problem (13).

Currently, in hospitals of Iran, for the bleeding of injectable serums, a pore is created by the needle in the upper part, or the air is drawn through the lower part, i.e., lower bleeding, which in both ways allows the serum fluid to be contaminated.

However, so far, no study has been done on this issue. Therefore, considering the importance of preventing hospital infections and the possible transmission of infection through serum bleeding, it seems necessary to investigate this issue. The aim of this study was to determine the frequency distribution of microbial contamination of injectable serums in the two methods of bleeding, i.e., upper and lower bleeding.

Materials and Methods

This is a descriptive-analytical study conducted in 2014 at Kashani Hospital in Shahrekord, southwest of Iran. The study population of this study consisted of inpatients in surgical and internal wards and under serum therapy from whom our patients were selected by convenience sampling.

Inclusion criteria were treatment with serum injected into the patient in various internal and surgical departments, agreement of the departmental authorities to sample the serum injected, and not adding antibiotics to the serum content.

The accidental contamination of serum during injection, such as the fall of serum from the hands of the administrator staff, and exit of serum from the patient's hand before it was completed, were exclusion criteria. Based on the sample size calculation formula, the number of the samples for each group was estimated at 125.

After labeling the serum with adhesive labels, the serum characteristics including the type, volume, production date, expiration date, and the type of auxiliary equipment, such as the type of set, the type of vein set or branula and their expiration dates, as well as the time of serum injection and the patient's characteristics, including age, gender, and the type of illness were recorded in a special checklist.

Serum characteristics, bleeding method, and other information were collected by one of the research team members and recorded in a checklist that had been designed, for this purpose, by a group of infectious specialists, surgeons, and statisticians. The results of microbial culture of the samples were also recorded in the checklist after they were received from the laboratory.

Bleeding method was also determined randomly; in the upper bleeding, the sets without bleeding pore (simple sets) were used, and a needle no. 22, after attaching the serum to the upper level of solution, was introduced into the container; and in the lower method, the sets with lower air inlet pores were used. After the completion of the serum, when 10 cc of the serum was left, 10 cc of serum solution was collected with a 10 cc syringe under sterile conditions and then was sent to the laboratory for microbial culture.
In the laboratory, the samples were cultured in eosin methylene blue agar and blood agar and a smear was prepared for simultaneous hot staining. After 72 hours, the growth of the bacteria in the samples was examined and the type of bacteria grown in the culture medium was determined and the results were recorded in the checklist for each serum.

Data were analyzed by the SPSS version 22. Statistical tests used for data analysis were t-test, Fisher's exact test, Chi-square test, and one-way ANOVA.

Results

Of the samples collected, 198 cases (79.2%) were 1/3–2/3, 25 cases (10%) Ringer's lactate, 15 cases (6%) normal saline, 4 cases (1.6%) Dextrose, and 8 cases (3.2%) other injectable serums (1 case of albumin, 1 case of homoxyl, 2 cases of vellon, and 4 with half-saline). In the upper bleeding group, 114 samples, and in the lower bleeding group, 84 samples of the injectable serum were 1/3–2/3 (82.6% vs. 75%).

Also, in the groups upper bleeding and lower bleeding, there were 15 and 10 serum solutions of Ringer's lactate type (10.9% vs. 8.9%). On the other hand, in the groups of upper bleeding and lower bleeding, there were 3 and 12 normal saline solutions (2.2% vs. 10.7%), 3 and 1 glucose solutions (2. 2% vs. 0.9%), and 3 and 5 injectable serums of other types (2.2% vs. 4.5%), respectively. According to the Fisher's exact test, the serum type was not significantly different between the two groups ($P = 0.06$).

The volume of injectable serum was 250 cc for 180 cases (72%), 1000 cc for 62 cases (24.8%), and 500 cc for 8 cases (3.2%). Serum expiration date was 1 year for 4 cases (1.6%), 2 years for 116 cases (46.4%), 3 years for 57 cases (22.8%), 4 years for 49 cases (19.6%), and 5 years for 5 cases (9.6%). The average interval between serum attachment to the patient and sample collection was 1.92 ± 1.19 hours.

Also, the time interval between serum attachment and sample taking for 116 cases (46.4%) was less than 2 hours, for 114 cases (45.6%) between 2 hours and 3 hours, and for 20 cases (8%) over 3 hours. 172 cases (68.8%) of the samples were collected in the morning shift, 42 (16.8%) in the evening shifts, and 36 samples (14.4%) in night shifts.
Of the 250 serum samples, 55 (22%) were collected from the surgical ward, 77 (30.8%) from the internal ward, 16 (6.4%) from the intensive care units, 28 (11.2%) from the pediatrics and gynecology wards, and 74 samples (29.6%) from the emergency department.

Among the 250 studied serums, upper bleeding was performed for 138 cases (55.2%) and lower bleeding for 112 cases (44.8%). The result of microbial culture was negative for 247 cases (98.8%) and positive for 3 cases (1.2%). The bacteria grown in the culture medium were Acinetobacter in 1 case (0.4%), fungus in 1 case (0.4%), and Staphylococcus epidermidis in 1 case (0.4%). There was no significant difference in the culture result in terms of bleeding method (P=0.59) (Table 1).

Interestingly, the Acinetobacter-containing samples were from the serums administered by upper bleeding and the fungus and S. epidermidis-containing samples were from the the serums administered by lower bleeding.

Table 1: Distribution frequency of culture results for the two methods of bleeding

Bleeding method	Negative		Positive		Total		P value
	Number	Percent	Number	Percent	Number	Percent	
Upper	137	55.5	1	33.3	138	55.2	0.59
Lower	110	44.5	2	66.7	112	44.8	
Total	247	100	3	100	250	100	

On the other hand, there was no significant difference in serum type between the two groups (P = 0.20) (Table 2). It should be noted that the Acinetobacter and fungus samples were observed in 1/3–2/3, and S. epidermidis in another type of serum (albumin).

Table 2: Distribution frequency of culture results for different types of serum solutions

Culture result in different types of serum solutions	Negative		Positive		Total		p-value
	Number	Percent	Number	Percent	Number	Percent	
Dextrose saline	196	79.4	2	66.7	198	79.2	0.20
Ringer's lactate	25	10.1	0	0	25	10	
Normal saline	15	6.1	0	0	15	6	
Dextrose	4	1.6	0	0	4	1.6	
Others	7	2.8	1	33.3	8	3.2	
Total	247	100	3	100	250	100	

There was no significant difference in the result of the culture according to the expiration date (P = 0.22) (Table 3). In addition, the expiration date for the Acinetobacter-, fungus- and S. epidermidis-containing samples was 3 years, 3 years, and 4 years, respectively.

Table 3: Distribution frequency of culture results for the expiration date of serums

Culture result based on serum expiration	Negative		Positive		Total		P value
	Number	Percent	Number	Percent	Number	Percent	
1 year	4	1.6	0	0	4	1.6	0.22
2 years	116	47	0	0	116	46.4	
3 years	55	22.3	2	66.7	57	22.8	
4 years	48	19.4	1	33.3	49	19.6	
5 years	24	9.7	0	0	24	9.6	
Total	247	100	3	100	250	100	

There was no significant difference in serum microbial culture among different hospital wards (P = 0.44) (Table 4). It should be noted that the Acinetobacter-containing sample was collected from gynecology surgery ward, the fungus-containing sample was collected from neurosurgery ward, and S. epidermidis-containing samples were collected from the urology ward.

Table 4: Distribution frequency of culture results in different hospital wards

Culture result in different wards	Negative		Positive		Total		P value
	Number	Percent	Number	Percent	Number	Percent	
Surgery	54	21.9	1	33.3	55	22	0.44
Internal	77	31.2	0	0	77	30.8	
Intensive care unit	16	6.5	0	0	16	6.4	
Pediatrics and gynecology	27	10.9	1	33.3	28	11.2	
Emergency	73	29.6	1	33.3	74	29.6	
Total	247	100	3	100	250	100	

The average time interval between serum attachment and sample collection for the positive culture samples was 5.83 ± 0.29 and for the negative culture samples was 1.87 ± 1.01 hours. According to the t-test, the difference between the two groups was significant (P < 0.001) (Table 5). Fisher's exact test also showed that there was a significant difference in the frequency distribution of microbial culture results in terms of the time interval between serum attachment and sample collection (P < 0.001).

Table 5: Distribution frequency of culture results for the time interval between serum injection and sample collection

Culture result based on interval between serum attachment and sample collection	Negative		Positive		Total		P value
	Number	Percent	Number	Percent	Number	Percent	
< 2 hours	116	47	0	0	116	46.4	0.00
2-3 hours	114	46.2	0	0	114	45.6	
> 3 hours	17	6.9	3	100	20	8	
Total	247	100	3	100	250	100	

According to the results, there was no significant association between the shift of sample collection and the microbial culture result (P = 0.13) (Table 6).

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Table 6: Distribution frequency of culture results for the shifts of sample collection

Culture result based on shift of sample collection	Negative		Positive		Total		P value
	Number	Percent	Number	Percent	Number	Percent	
Morning	171	69.2	1	33.3	172	68.8	0.13
Evening	40	16.2	2	66.7	42	16.8	
Night	36	14.6	0	0	36	14.4	
Total	247	100	3	100	250	100	

There was no statistically significant difference in age, length of hospital stay, gender, and having catheter between the positive culture and negative culture groups (P > 0.05) (Table 7).

Table 7: Frequency distribution of microbial culture results with respect to demographic characteristics

Culture result Variable		Positive	Negative	P value
		Mean±SD	Mean±SD	
Age		70.7±15	57.3±23.6	0.33
Length of hospitalization		4.33±2.08	8.77±12.8	0.55
Variable		N (%)	N (%)	p-value
Sex	Male	1 (33.3)	159 (64.4)	0.30
	Female	2 (66.7)	88 (35.6)	
Catheter	Yes	3 (100)	191 (77.3)	0.59
	No	0 (0)	56 (22.7)	

Discussion

The general aim of this study was to determine the frequency distribution of microbial infection of injectable serum solutions in the serums administered via upper and lower bleeding. In this study, of the 250 serum samples collected from injectable serum solutions administered to hospitalized patients, 3 samples (1.2%) had culture positive. The study by Gupta et al. also showed that unsafe injection increased the incidence of hepatitis B in the community (6).

For serum type, the bacterial infection for 2 cases (66.7%) was found in 1/3–2/3 solutions and 1 case (33.3%) was observed in another type of solution (albumin).

The point to consider is that serums containing biological compounds such as albumin and blood, due to providing a good environment for bacterial growth, are more exposed to contamination, and in contrast saline serum solutions, such as normal saline, due to being an unsuitable environment for microbial growth, have less potential for contamination. Thus is especially important for storage of injectable serums (14).

In terms of expiration date, out of three positive cultures, the expiration date of 2 samples (66.7%) was 3 years and the expiration date of 1 sample (33.3%) was four years; and although there was no significant difference between the two methods of bleeding due to the small number of cases of positive culture, several studies have shown that injectable solutions, after expiration date, in addition to being predisposed to potential chemical changes in the solution, are also predisposed to microbial growth, which can be due to the provision of suitable conditions for microbial growth in the deformed solution, damaged package, or preservatives (15).

In terms of hospitalization, of the three positive culture samples, one was collected from the surgical ward, one from the gynecology ward, and one from the emergency ward. So far, numerous studies have been performed on environmental contamination in different wards of the hospital, most of which have shown that infectious disease and surgical wards have higher environmental contamination than other wards, and, in contrast, transplantation and surgical have the lowest environmental pollution (16).

Another noteworthy point is the storage conditions of injectable solutions in drug depots and hospital wards, which may lead to contamination and the growth of microbial agents due to possible damage and unfavorable storage conditions. Even, in certain cases, skin contamination can cause infection despite performing decontamination. A study conducted by Wang et al. in 2015 showed that Staphylococcus aureus could cause infection in a standardized decontamination device because of resistance to disinfectants (17).

Injectable serum solutions are completely sterile liquids and no microbial contamination, whether pathogenic or non-pathogenic, should be detected in them, and the contamination of the samples studied is likely to be due to secondary contamination during injection due to non-

compliance with sterile conditions when installing fittings to the solution.

On the other hand, the contamination of the air in different wards of the hospital with bacteria is also likely, and therefore it is argued that the passage of air bubbles from the solution that is being infused in the serum solutions that are administered by lower bleeding causes solution contamination. In our study, 3 cases of contamination were observed, of which 2 cases were found in the serum solutions administered by lower bleeding.

However, because of the very low prevalence of microbial contamination in injectable solutions, the observation of 3 cases of contamination can be an accidental finding and not related to the method of bleeding, although other studied variables in the samples of positive culture and negative culture also showed that the interval between serum attachment to the patient and sample collection had a significant effect on the contamination of the solution. Therefore, the microbial contamination of injectable solutions is most likely to be due to the entry of the air with bacterial contamination during bleeding or non-compliance with sterile conditions when connecting the injection set to the serum solution bottle.

Conclusion

The bleeding of injectable serum solutions has contributed to the contamination of injectable serums due to indoor air contamination in the hospitals, and although the bleeding method did not cause any significant difference in the number of infection development, the number of infected cases was higher for the serum solutions that were administered by lower bleeding.

Therefore, it is recommended that for the injectable serum solutions, upper bleeding be used as much as it is possible so that the likelihood of contamination of injectable serum solutions is minimized. It is also recommended that long-term serum administration of the serum solutions to patients be avoided, especially if the patient is transferred to different wards.

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