Microbial Contamination due to Malpractice during Administration of Intravenous Fluids in Baghdad Hospitals

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الخلاصة:

الهدف من هذه الدراسة هو لبيان وجود أو عدم وجود تلوث بكتيري و/أو فطري في المحاليل الوريدية نتيجة الإعطاء الخاطئ لهذه المحاليل في المستشفيات العراقية في بغداد. أجريت هذه الدراسة خلال شهر أيار إلى شهر أب عام2010، فقد تم جمع 113 عبوة محلول وريدي مستعملة سريرياً وتم تصنيفها إلى مجموعتين رئيسيتين: الأولى المثقوبة في جسم العبوة (مجموعة الاختبار) والثانية غير مثقوبة (مجموعة السيطرة). المجموعة الأولى صنفت إلى مجموعتين وهي: عينات عبوات المحاليل الوريدية التي تحوي إبرة المحقنة وتركت الإبرة خلال إعطاء المحلول لتسهيل سريان السائل (73 عبوة) والأخرى (12عبوة) وهي المحاليل المثقوبة من أعلاها بإبرة خلال مزج الدواء في المحلول الوريدي عن طريق حقنه مباشرة في جسم العبوة ثم رفعت الإبرة. المجموعة الثانية (السيطرة 28 عبوة) لمحلول وريدي سليمة وغير مثقوبة بعد انتهاء إعطائها للمرضى. العينات جمعت من مستشفيات بغداد التعليمي (76) وابن النفيس (33) والكاظمية التعليمي(4).

تمت عملية زرع لقطرات من هذه المحاليل مباشرة بعد جمعها في وسط زرعي مناسب في مختبر الأحياء المجهرية وأظهرت النتائج أن نسبة التلوث في المحاليل التي تم إحداث ثقوب فيها بواسطة الإبر هي (79.45%) بينما نسبة التلوث في المحاليل المثقوبة ولكن بدون ابر هي (100%) بينما نسبة التلوث في المحاليل غير المثقوبة هي (28.57%). وتم تسجيل الجراثيم الثلاثة الأكثر تسببا في التلوث للمحاليل الوريدية وهي:

Escherichia coli، Stapylococcus epidermidis، Candida albicans

Abstract:

The present study was designed to investigate the suspected bacterial and/or fungal contamination in intravenous (IV) fluids due to malpractice of administration in Baghdad hospitals. The study was conducted during the period

from May to August 2010. One hundred and thirteen intravenous fluid samples were collected from different wards in Baghdad teaching hospital, Ibn Al-Nafees teaching hospital and AL Khadhemia teaching hospital in district of Baghdad. These samples were classified into 2 main groups: Group 1 (test group), include I.V. fluids with inappropriate position puncture in the bag; and group 2 (control), include I.V. fluids free from inappropriate puncture in the bag. Then group 1 samples were sub-classified into 2 groups; Group 1A: includes 73 I.V fluid bags with needle puncture by staff nurses in which the needle was left during the use to ease flow; group 1B: includes 12 I.V fluid bags in which a puncture was made in the bag during inappropriate I.V admixture and the needle was removed; and group 2: 28 I.V fluid bags (control) free from any inappropriate puncture. Samples from all I.V fluid bags (113) were cultured immediately after collection in a proper media for bacteriological examination. Results of cultures showed that a 79.45% contamination was present in I.V fluid bags samples from group 1A (n =73), while 100% contamination was reported in I.V fluid bags samples from group 1B (n=12) and 28.57% contamination in the group 2 (n=28). In the our study, the most common three microbes contribute for contamination of infusate are *Candida albicans , Stapylococcus epidermidis* and *Escherichia coli*.

In conclusion, the widely followed improper practice for preparing and administration of I.V. fluids in some of Baghdad hospitals may predispose to fatal bacterial contamination.

Key word: I.V. fluids, microbial contamination

Introduction:

Intravenous administration of fluids, drugs and nutrition is very common in hospitals [1]. In modern medical practice, up to 80% of hospitalized patients received I.V. therapy at some points during their admission [2]. In the past decades, attention has been focused on the contamination of such solutions by microorganisms and their cellular by-products, which may result in increased patient mortality and morbidity. Gram-negative bacteria such as *Klebsiella, Pseudomonas, Serratia, Flavobacterium,* and several fungi are the principal agents associated with contamination of sterile fluids; these organisms have the ability not only to survive in sterile fluids but also to grow to densities of 10^5 cells per milliliter without visible turbidity [3]. It has been reported that micro-organisms can gain access to intravenous infusions during administration [4,5]. It has been clearly established that microbial contamination can arise from the influx of unfiltered air [6], the addition of drugs [7], and by the migration of microorganisms through the cannulae of the administration set [8]. Between summer 1970 and March 1971, many U.S. hospitals experienced outbreaks of intravenous-associated septicemia with *Enterobacter cloacae* and *Enterobacter*

agglomerans [9,10]. The intrinsic and extrinsic microbial contamination of large-volume parenterals has been associated with bacteremias in hospitalized patients[11], and nosocomial infections associated with the intrinsic and extrinsic microbial contamination of large-volume parenterals, such as glucose-containing solutions, are well documented [12,13,14,15,16]. Although intrinsic (i. e., from the manufacturer) infusate contamination is rare, high rates of extrinsic (i. e., from in-use manipulation) contamination are present in hospitals with poor nursing standards, which predispose to bacteremia outbreaks [17,18]. The present study was designed to evaluate contamination of I.V fluids due to malpractice of administration in certain hospitals within Baghdad district area.

Materials and Methods:

Sample Collection:

Samples of I.V fluid bags (113 bags) were collected from different hospitals within Baghdad governorate area (Table-1); these I.V fluids were administered to the in-patients in these hospitals according to prescribing notes and followed the currently adopted technique for administration by the nurse staff without intervention by the researchers; all samples were taken before removal of the administration set from the patients in an aseptic technique.

Baghdad teaching hospital	76 sample
Ibn Al-Naphees hospital	33 samples
Al Kadhemia teaching hospital	4 samples

Table-1: Distribution of collected I.V fluid bags samples according to the hospitals.

The samples were ranked into 2 main groups as follow: group-1 (test group) and group-2 (control group); then the first group subdivided into group-1-A (n=73) that includes I.V. fluid bags punctured with needle into the body of the bag, and the needle was left to ease the flow of fluid (Figure-1), and group-1-B that includes I.V bags punctured during inappropriate I.V admixture preparation and needles were removed from the body of the I.V fluid bags after delivery of drugs into the I.V fluid. The second group (group-2) includes I.V fluid bags without producing puncture in the body of the bags.

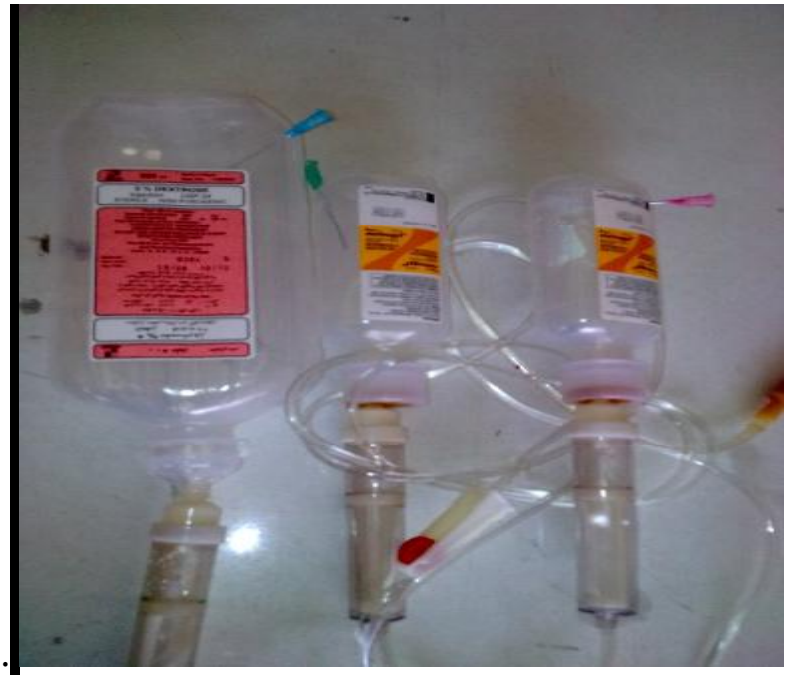

Figure-1: Intravenous fluid bags punctured with needle in the body of the bag (group-1-A).

Materials:

Random samples of different brands of intravenous fluids given to the patients in selected hospitals in Baghdad city, produced by different pharmaceutical companies (Table-2). Most of the samples are 500 ml plastic bags except metronidazole for I.V administration, which is plastic 100 ml bottle, and human albumin 20% is 100 ml glass bottle.

Media used and preparation:

The media used for the microbiological analysis include, Nutrient Agar, Eosin Methylen Blue Agar, MacConkey Agar, Saboraude Dextrose Agar, Mannitol Salt Agar, Tryptone Soya Agar and Tryptone Soya Broth. The media were prepared according to the manufacturer's instructions.

Methods:

Microbiological analysis:

All materials and equipments were sterilized before use and aseptic techniques were utilized during the study. Each sample of I.V fluid was dropped in duplicate tubes of Tryptone soya broth, one of them was incubated at 37^{o}C for 24 hrs (for detection of bacterial growth), and the second was incubated at 25-28^{o}C for 7 days (for detection of fungal growth). The tubes were observed on daily bases for visible turbidity that indicate microbial growth; any tube with visible growth was removed and the contents were subcultured into solid media

for differentiation and characterization. All isolates were fully characterized biochemically [19].

Type of IV fluid	Composition	Manufacturing company	Country of origin	No. of samples
N/S (normal saline)	0.9% NaCl	Pharmaceutical Solution Industry	Saudia Arabia	31
		ADWIC Pharm Division	Egypt	
D/W Dextrose water	5% glucose	Nile company	Egypt	18
		ADWIC Pharm Division		
D/S Dextrose saline	4% G/W + 0.18% NaCl	Demo SA Pharm. Industry	Greece	18
D/S Dextrose saline	2.5 % G/W + 0.45% NaCl	Pharmaceutical Solution Industry	Saudi Arabia	4
D/S Dextrose saline	5% G/W + 0.9% NaCl	ADWIC Pharm Division	Egypt	1
Ringer's solution (500 ml)	NaCl 8.6 mg, KCl 300 mg, $CaCl_2$ 322 mg/ml	Pharmaceutical Solution Industry	Saudi Arabia	11
		Gulf injection LLC	UAE	
Metrogyl® bottle	Metronidazole 500mg/100ml	JB Chemical and Pharmaceutical LTD	India	26
Human albumin 20%	Human albumin 100 ml bottle	Biotest GmbH	Germany	3
Mannitol 10%	Mannitol 10% 500ml bottle	ADWIC Pharm Division	Egypt	1
Total				113

Table-2: Types and manufacturers of the selected I.V fluid containers included in the study.

Aerobic plate count:

One milliliter of the fluid was inoculated in tryptone soya broth (9.0 ml) according to B.P 2004 [20], using a flask shaker and suitable serial dilutions. Then, one milliliter sample of each dilution was poured in a sterile Petri dish, and then 15 ml of a sterile tryptone soya agar was poured on the sample; the plates were gently swirled in a round movement to allow good mixing of the agar with the sample, then the plates were allowed to solidify on a leveled surface. Triplicate plates for each sample were used and incubated at 35^{o}C-37^{o}C for two days. Saboraude dextrose agar was used instead of tryptone soya agar for the detection of fungi. The prepared plates were incubated at 25^{o}C for 5 days; after incubation, the number of colonies was counted by estimating the total count of the growing bacteria and fungi then the mean of three plates was calculated. A laboratory control count was performed using negative blank (without fluid) and with positive control (contaminated fluid). More than two colonies on the negative control plate invalidated the test, and colony counts exceeding 1000 were considered too high to count and the fluid further diluted. Plates with colonies of 30-300 were selected. The microorganism content per milliliter is the colony count multiplied by the appropriate dilution factor (10 or100)

Results:

(Table-3) shows that the I.V fluid bags collected from internal medicine wards have the highest percent (71.4%) of contamination, followed by gynecology (60.0%) and surgery (57.1%) wards respectively. In table-4, normal saline demonstrates the highest level of contamination (80.65%) followed by D/S, metronidazole, Ringer's and D/W solutions respectively. Stratification of data according to allocated groups revealed that 100% contamination was reported in group 1B, followed by groups 1A and 2 respectively (Table-5). In the present study, the most common three microbes contribute for contamination of I.V. fluids are *Candida albicans* (yeast-like fungus), *Stapylococcus epidermidis* (Gram-positive cocci) and *Escherichia coli* (Gram-negative rod) with incidence of 61.54%, 48.72% and 38.46% respectively (Table-6). The least three microbes contribute for I.V. fluid contamination are Gram-negative rods bacteria*: Serratia marcescens*, *Enterobacter cloacae, Proteus mirabilis* with incidence of 1.28%, 5.13% and 6.4% respectively (Table-6). Concerning the microorganism count, Mannitol 10% solution shows the highest level of bacterial and fungal count among the other types of I.V fluids that are ranked in group1A (Table-7). In group 1B, normal saline shows the highest level of both bacterial and fungal count (Table-8). Moreover, in bags where no needle puncture induced, dextrose water and normal saline demonstrated recognizable degree of bacterial and fungal count respectively compared to others (Table-9).

Type of hospital ward	Total number of bags screened	No. and percentage of contaminated bags
Internal Medicine	70	50 (71.4%)
Surgery	28	16 (57.1%)
Gynecology	15	9 (60%)

Table-3: Percentage of contamination in the selected I.V fluid bags

I.V. fluid name	Total No of bags	No. (percent) of contaminated bags	No. (percent) of no contamination
N/S (0.9%NaCl)	31	25 (80.65%)	6 (19.35%)
D/W 5%	18	10 (55.56%)	8 (44.44%)
D/S (3 types)	23	17 (73.91%)	6 (26.09%)
Ringer's sol.	11	7 (63.64%)	4 (36.36%)
Metronidazole I.V solution	26	18 (69.23%)	8 (30.77)

Table-4: Number and percentage of microbial contamination for each type of intravenous fluid.

Group	Total no. of bags	No. (percent) of contamination	No. (percent) of no contamination
Group-1-A	73	58 (79.45%)	14 (20.55%)
Group-1-B	12	12 (100%)	0.0 (0 %)
Group-2	28	8 (28.57)	20 (71.43%)
Total number	113	78 (69.0%)	34 (31.0%)

Table-5: Number and percentage of contaminated I.V. fluid bags for each group.

Type of microorganism	0.9% NaCl n=22	D/W5% n=12	D/S (3types) n=18	Ringer Solution n=7	Metrogyl©solution n=16	Human albumin n=2	Mannitol 10% n=1	Total No. (%) n=78
Staphylococcus aureus	3	1	2	--	2	--	--	8 (10.26%)
Staphylococcus epidermidis	13	7	7	3	5	2	1	38 (48.72%)
Bacillus cereus	2	2	2	1	3	--	--	10 (12.82%)
Escherichia coli	7	5	7	3	8	--	--	30 (38.46%)
Klebsiella pneumonia	1	2	2	2	2	1	--	10 (12.82%)
Pseudomonas aeuruginosa	2	1	6	4	5	--	--	18 (23.1%)
Enterobacter cloacae	1	1	1	1	--	--	--	4 (5.13%)
Serratia marcescens	--	--	--	--	1	--	--	1 (1.28%)
Proteus mirabilis	4	--	1	--	--	--	--	5 (6.4%)
Aspergillus spp.	3	2	4	--	--	--	--	9 (11.54%)
Penicillium spp.	4	1	2	--	1	1	--	9 (11.54%)
Candida albicans	14	8	11	2	12	--	1	48 (61.54%)

Table-6: Type of microorganisms isolated in each contaminated I.V. fluid bags.

Microbial count was done to 20 I.V. fluids, those distributed over the 3 groups as follows: group-1-A n=14, group-1-B n=2, group-2 n=4. The count done to samples that cover all brands in the study but not on specific basis. Results are shown in the following tables.

Type of I.V. fluid	Bacterial count (average) C.F.U/ml	Fungal count (average) C.F.U/ml
N/S (n=2)	6×10^4	4×10^3
D/W 5% (n=2)	3×10^4	1×10^3
D/S (n=2)	7.5×10^4	1×10^4
Ringer's solution (n=2)	4×10^4	8×10^2
Metronidazole solution (n=2)	5.5×10^4	7×10^3
Mannitol 10% (n=1)	1.2×10^5	2.1×10^4
D/S (0.9%NaCl+5%Gw) (n=1)	6.8×10^4	5×10^3
Human albumin 20% (n=2)	7.6×10^4	3×10^2

Table-7: Microbial count in group-1A (I.V. fluid bags with needle) C.F.U (colony forming unit)

Type of I.V fluid	Bacterial count C.F.U/ml	Fungal count C.F.U/ml
N/S	8.2×10^4	2×10^3
D/W 5%	2×10^4	1.2×10^3

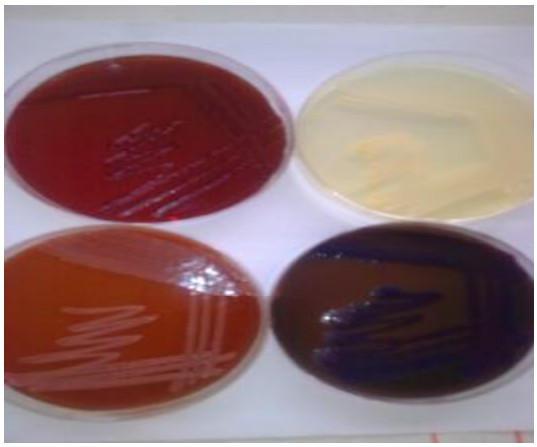

Figure-2: Microbial growth on different agars.

Type of I.V fluid	**Bacterial count** C.F.U/ml	**Fungal count** C.F.U/ml
N/S	6×10^3	2×10^2
D/W 5%	2×10^3	1.0×10^3
Ringer's solution	0.0	0.0
Metronidazole solution	0.0	0.0

Table-9. Microbial count in group 2 (intact I.V fluid bags)

Discussion:

Our research deals with a common problem due to malpractice during mixing and administration of I.V fluids in Iraqi hospitals rather than in other developed countries; therefore, there are no enough data or literatures that deal with the subject of contamination in I.V fluids in such way. (Table-3) showed that the I.V. fluids collected from internal medicine wards have highest percent of contamination; this may be due to high incidence of infections in this ward (e.g. respiratory tract infections) in both hospitals, Baghdad and Ibn Al-Naphees. (Table-5) showed that group-1-A and group-1-B have contamination levels of 79.45% and 100 % respectively, this high percent of contamination in both groups is thought to be due to induced puncture in the bag body by needle of syringes by nursing staff, which leads to contamination due to entry of microorganisms from the environment of ward. We suspected that small percentage of microbial contamination (28.57%) detected in control group was induced during insertion of the administration set [21], inappropriate handling of I.V. set by the nursing staff during the change of I.V. fluids, or may be due to the use of the same I.V. set for more than 24 hours. (Table-7) showed that group 1A has highest microbial count for both bacteria and fungi; this may be attributed to that the quantitative factor of contamination, where the amount of bacteria and/or fungi are high within the area of the needle orifice, which facilitate the entry of microbes into I.V. fluid. However, the presence of any living microorganism in the I.V. fluids could result in septicemia and/or nosocomial blood stream infection regardless of the type or count of these contaminating microorganisms. Several reports in the last decade have adduced cases of septicaemia due to the use of contaminated I.V fluids or inappropriate procedure of administration [22,23,24,25] In a study held in 2010 in Mexico City; 384 infusates were cultured from 384 patients showed that in all cases, the infectious organism was the same as the organism isolated from blood of those patients [26]. The incidence of hospital acquired (nosocomial) infections has been

estimated by the World Health Organization (WHO) to vary between 3 and 21% of hospital admissions. Occurrence of these infections leads to requirement for further type of treatment and increased hospital stay, with increased costs and nursing time [27]. Nosocomial bloodstream infections are a leading cause of death in the United States. If we assume a nosocomial infection rate of 5%, of which 10% are bloodstream infections, and an attributable mortality rate of 15%, bloodstream infections would represent the eighth leading cause of death in the United States [28]. In conclusion, contamination in the I.V. fluids in Baghdad hospitals was mostly due to extrinsic factors (during clinical use), most probably attributed to induction of needle puncture in the body of I.V. fluid bags by nursing staff. Accordingly, education of nursing staff and others who practice the duty of preparation and administration of I.V fluids should be strongly addressed.

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