



Determining the Distribution Rate of *Staphylococcus aureus* in Hemodialysis Patients in Alassad Hospital

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Received: 09-02-2017; Revised: 26-03-2017; Accepted: 15-04-2017.

ABSTRACT

Our study aimed to investigate about the nasal carriage of *Staphylococcus aureus* and its prevalence between hemodialysis patients and medical staff and its role as a risk factor in the occurrence of bacteraemia in hemodialysis department in Al-Assad Hospital. This study included 124 participants, with mean age of (50.77 ±15) years, containing 60 male and 64 female. Hundred and ten of them were patients and fourteen of them were members of the medical staff, all patients had undergone 3-4 hours hemodialysis sessions twice a week, with mean hemodialysis duration of (25.50 ± 21) months, the study was established from June 2010 till May 2011, and three nasal screen per participant were gathered. The rate of three screen was respectively (38.7%, 40.3%, 46.8%), the Permanent carriage recorded the highest ratio compared to the negative and intermittent which rate were respectively (%17.7,%38.7,%43.5), (P. C. A.) showed that the Permanent nasal carriage of *Staphylococcus aureus* and center catheter infection has a major role in the occurrence of bacteraemia in these patients. This study allowed us to identify hemodialysed patients who carry *S.aureus* as a high risk group to bacteraemia that appears to begin from endogenous origin in the nasal mucosa. Thus it's necessary to implement individual and collective hygiene guidelines, and expand the treatment and preventing in hemodialysis unit and wide spread this to the important centers in Syrian hospitals.

Keywords: Nasal carriage, *Staphylococcus aureus*, Hemodialysis, Bacteraemia.

INTRODUCTION

Mortality rate in End Stage Renal Disease (ESRD) patients is higher than in general population¹. In such patients, infectious complications are considered the main etiology of morbidity and the second one of mortality just after cardiovascular diseases². Up to date, *Staphylococcus aureus* are accounted to be the most inducer of these infections^{3,4}. They are among leading and important pathogenic agent which cause bacteraemia⁵. Multiple studies pointed to *Staphylococcus aureus* bacteraemia (SAB) mortality proportion, it amounted to (17-25%),⁶ were recurrence reached (18%)⁷. *Staphylococcus aureus* nasal invasion –which was considered the principle endogen warehouse- plays the key role of these infections morbidity⁸, owing to geno-determined neighborhood between mucosal nasal cells and some bacteria including *Staphylococcus aureus*.⁹

Catheters and bypasses used in hemodialysis represent the leading access to induce blood infections.¹⁰ It has been proved that the blood isolated *Staphylococcus aureus* strains are similar to nasal isolated ones.¹¹ And staphylococcal nasal carriage increases blood infections probability in ESRD patients.¹²

This study aimed to detect the prevalence and nasal carriage of *Staphylococcus aureus* in both hemodialysed patients and medical staff in artificial kidney department, Al-Assad University Hospital, Latakia. How extensive hemodialysed patients are exposed to blood infection or any other infection eventually caused by endogen *Staphylococcus aureus* is another target of this study, in

addition to illustrate the most important risk factors of blood infection in study sample. The importance of our study steams from our ability in extracting results leading to establish preventive mechanisms and effective therapeutic strategies in forbidding such infection occurrence; and consequently morbidity and mortality proportion will decrease in hemodialysed patients.

This study represented an attempt to put forward an image on hemodialysis status in the aforementioned centers from blood infection standpoint (origin, occurrence and prevalence, and the relation between *Staphylococcus aureus* nasal carriage and blood infections reports); and consequently, highlighting defects that need correction with a possibility in generalizing the study recommendations on Syrians' hemodialysis centers.

MATERIALS AND METHODS

Study sample comprised 124 participants put into two groups:

1. Hemodialysed subjected patients group: (110 patients): all patients had had two sessions a week, 3-4 hours long each.
2. Artificial Kidney Department medical staff: (14 subjects)

The study extended from June 2010 to May 2011. Three swabs were collected from each participant by introducing sterile cotton swab into nostril at least 2cm in depth and rotating it five times against nasal wall (souly,201):



First swab was taken at the first and the second months of the study Second swab at the fifth and the sixth months of the study Third one at the tenth, eleventh, and the twelfth months of the study Participants' ages ranged from 16 to 85 years (50.77 ± 15 in mean) and the mean of hemodialysis times was (25.5 ± 21 months) Patients' characteristics (age, sex, hemodialysis times, and diabetes mellitus) were gathered and ordered.

Table 1: participants' characteristics*: regarding the importance of advanced ages, the latter was restricted to 65 years in our study

Characteristics		Number	Percentage
Age	≤ 65 *	22	18
	>65 *	102	82
Sex	Male	60	48.4
	Female	64	51.6
Total		124	100
Hemodialysis Times	≤37	91	83
	>37	19	17
Diabetes mellitus	Yes	50	45
	No	60	55
Total		110	100

Table 2: Age groups distribution in the study sample

Age group	Number	Percentage
16-25	7	5.6
26-35	19	15.3
36-45	21	16.9
46-55	26	21
56-65	29	23.4
66-75	17	13.7
76-85	5	4
Total	124	100

Table 2: shows age groups distribution in the study sample, and the most frequent group was (56-65 years)

Patients files were reviewed and medical information relating to registered infections kinds were collected. Founding on the previous, *Staphylococcus aureus* induced infections –which were the most important for our study– were classified and the result was put in Table (3):

Table 3: registered infections in study samples

The infection kind		Number	Percentage
Central Catheter infection	Yes	43	39.1
	No	67	60.9
Arterio-venous shunt infection	Yes	16	14.5
	No	94	85.5
Blood infection	Yes	14	12.7
	No	96	87.2
Total		110	100

372 samples were collected and soon cultured -in time prior to one hour- on blood agar medium, first by flattening way and then by wrinkling by plastic culture loops and finally incubated at 37 temperature for 24-48 hours in an aerobic atmosphere. *Staphylococcus* genus was distinguished by the colonies remarks, Gram's staining and Catalase test; whereas *Staphylococcus aureus* species was determined by coagulase test and Mannitol fermentation on Chapman's milieu. All analysis was realized in Al-Assad University Hospital – Latakia.

Statistical Analysis

Results arrangement and some statistical studies were done as follows:

- percentage determination of acquired results after each factor in conformity with swabs results and blood infection
- Correlation coefficient after Spearman in view to know correlation linkage degree between each of the studied factors and *Staphylococcus aureus* nasal carriage or blood infection.
- Principal Components Analysis (PCA) was used to get doubtlessness of risk factors influence and each other reaction, by putting into prominence the contribution level in the explained divergence between them. SPSS.11 statistical program was used for that purpose.

RESULTS AND DISCUSSION

Staphylococcus aureus screening

First, second and third swabs results was evaluated as evidenced in Table (4), where it was observed an increased proportion of *Staphylococcus aureus* diffusion in study participants.

Table 4: *Staph. aureus* diffusion proportion among study participants

Swab Order	First	Second	Third
percentage	38.7	40.3	46.8

We also observed, during the 12 months of control, a great conversion into intermittent or permanent carriage state. This fact confirmed the role played by *Staphylococcus aureus* carrying patient as a storehouse for transmission in the department and for other patients. On the other hand, medical staff also formed a permanent and important warehouse in *Staphylococcus aureus* diffusion as a conclusion of direct contact with patients.

Depending on the three swabs results, three types of nasal carriage were distinguished

- 1) Non-carriers: all taken swabs were negative
- 2) Intermittent carriers: positive swabs were inferior to 66% of all taken swabs
- 3) Permanent carriers: positive swabs were equal or superior to 66% of all taken swabs

Table 5: shows the percentage of these three groups distribution:

Carriage type	Number	Percentage
Permanent carriers	54	43.5
Intermittent carriers	22	17.7
Non-carriers	48	38.7
Total	124	100

Table(5): *Staphylococcus aureus* nasal carriage type in our study *Staphylococcus aureus* permanent carriage percentage amounted to 43.5% ; table(6) compares our study results to other international ones which had taken similar standards to evaluate permanent carriage in hemodialysed patients . Superior and inferior rates to ours were recorded.

We observe from the previous table –more precisely in Poland Koziol-Montewka and Co. study on the same patients group- a difference between ante-therapy and post-therapy states; this confirms the importance of treatment in *Staphylococcus aureus* permanent nasal carriage problem, especially in hemodialysed patients.

Infections investigations

Via inquiry results, the most frequent infections encountered in hemodialysed patients participated in the study were classified as follow:

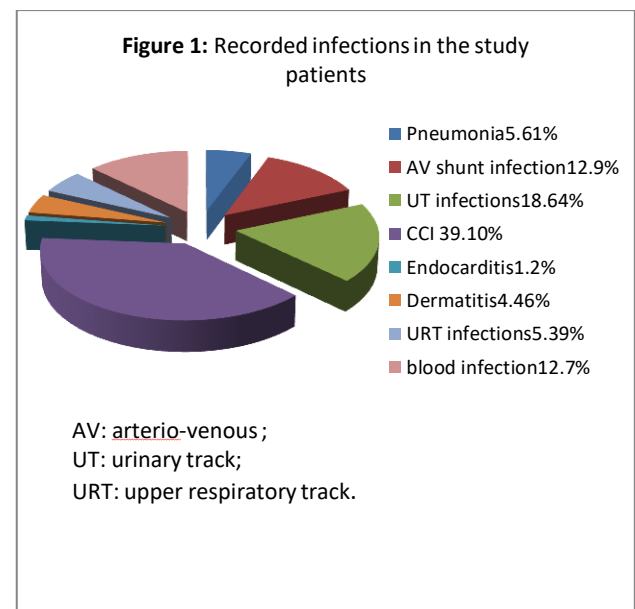
- Central catheter infection CCI: the highest compared to other infections 39.1%
- Blood infections BI: it has a prominent importance requiring awareness 12.7%
- Other infections have a divergent proportions; endocarditis the lowest one 1.2%

Table 6: permanent carriage percentage in different studies results

The study	Year	Country	PCP*
Boelaert	1995	Belgium	58
Koziol-Montewka	2001	Poland	57.1
Pena	2004	Spain	55
Our study	2011	Syria	43.5
Ternois	1993	France	31.4
Muro	1991	Belgium	30
Koziol-Montewka	2006	Poland	27.9
Edoh	2003	Ivory coast	21.4
Souly	2011	Morocco	18.52
Montagnac	1995	France	11.25

*PCP: permanent carriage percentage

So, it's mandatory to deal seriously with these cases to emphasize with their etiologies and treatments in view to keep patient's life safe from nosocomial possibility



Blood infection risk factors

The most frequent aid factors for blood infections in renal failure patients were outlined, and there were an agreement with risk standards determined by international studies (13) which are: sex, advanced age, central catheter and Arterio-venous shunts, diabetes mellitus, hemodialysis period and staphylococcus aureus nasal carriage.

These factors were studied from the standpoint:

- Blood infection and the three swabs results distribution in referring to risk factors

- Statistical study demonstrates the relation of these factors to the three swabs results (Spearman) , and make an arrangement after the importance in causing blood infection occurrence in conformity with Principal Components Analysis.

Blood infection and the three swabs results distribution in respect of risk factors

1. Sex:

The three swabs results were distributed according to sex, which might play an important role in blood infection probability; in order to know the relation

between sex and the three swabs results or blood infection. Some studies proved the increased possibility for blood infection among males, whereas others denied any sexual differences.

In our study, demonstrated the proximity of *Staphylococcus aureus* nasal carriage rate between two sexes (46.7% in males, 40.6% in females), and proved the converge of blood infection percentage as well (11.7% in males, 14% in females). Tab (7).

Table 7: nasal carriage and blood infection distributions according to sex

Sex	Total number of participants	Number of nasal carriers	Nasal carriage percentage	Number of blood infection cases	Blood infection percentage
Male	60	28	46.7	7	11.7
Female	64	26	40.6	7	14

Our study revealed that sex has no statistically significant relation with nasal carriage or blood infection; this may be a result of sample blindness. Our results were concordant with other international ones (11), but discordant with others. Souly's study were applied to 54 hemodialysed patients in which female *Staphylococcus aureus* nasal carriage and blood infections were superior to male ones.

2 Age:

The three swabs results were distributed according to age, which might play an important role in blood infection probability, especially in advanced ages, in order to know the relation between age and the three swabs results or blood infection. It seems from the Tab (8) that the highest rate of permanent carriers was in 56-65 years age group (29.6%), and so the blood infection (17.2%); whereas no great differences between the other age groups.

Table 8: nasal carriage and blood infection distributions according to age

Age group	Total number of participants	Number of nasal carriers	Nasal carriage percentage	Number of blood infection cases	Blood infection percentage
16-25	7	4	7.4	0	0
26-35	19	9	16.7	2	10.5
36-45	21	5	9.3	1	4.8
46-55	26	10	18.5	4	15.4
56-65	29	16	29.6	5	17.3
66-75	17	8	14.8	2	11.8
76-85	5	2	3.7	0	0
Total	124	54	100	14	100

Hence, advanced age has no statistically significant relation with nasal carriage or blood infection (concordant with Souly's results 2011), where the 56-65 years age group had the highest percentage of both nasal carriage and blood infection cases. This may be a result of relatively low mean age of our study participants (50.77±15), which is similar to Moroccan study (44.16±14) But, our study results were discordant with Saxena and co.'s ones (2004). Saxena's study was applied to 205 hemodialysed patients in Saudi Arabia, the mean age of participants was relatively high (73.44±17) , the 75-84 years age group registered the highest percentage in both cases. His study concluded: the advanced age plays an

important role *Staphylococcus aureus* nasal carriage and hence blood infection in those patients.

2. Central Catheter Infection:

Central catheter represents one of the most important accesses inducing infection in hemodialysed patients. Our study showed that central catheter infection is the most frequent infection caused by *Staphylococcus aureus* (39.11%) as shown in Tab(9), taking into consideration *Staphylococcus aureus* nasal carriage is an additional risk factor for this infection. The maximal rate of central catheter infection was recorded in *Staphylococcus aureus* permanent carriers (69.8%)



as shown in Tab(10), while the rates of intermittent and non carriers were contiguous (16.3% and 15%) respectively. Blood infection was in company with (78.6%) of central catheter infected patients.

Table 9: Central catheter infection percentage

Central Catheter Infection	Rate without staff	
	Patients number	percentage
Absent	67	60.9
Present	43	39.1
Total	110	100

Table 10: evidences nasal carriage and blood infection distribution in respect of Central Catheter Infection

Case	Total number	Central Catheter Infected number	Case percentage
Permanent Carriers	49	30	69.8
Intermittent Carriers	20	7	16.2
Non-Carriers	41	6	14
Total	110	43	100
Blood Infection	14	11	78.6

There is a clear relation between central catheter infection from one side and both of the three swabs results (aureus carriage) and blood infection on another side. These results are concordant with Von Eiff's ones (14) which registered in summary that the most frequent infection accounting for endogen *Staphylococcus aureus* blood infection is one of catheters used in variable treatments especially the central one leading to SAB in 46% percentage.

Diabetes Mellitus

We studied diabetes mellitus D.M as an additional factor contributing in infection occurrence probability in

hemodialysed patients. The three swabs results and blood infections were distributed in respect of D.M, Tab (11). We observed that 60% of diabetics were permanent carriers, and this percentage was the maximal if compared with intermittent and non-carriers diabetics. Also, 85.7 of blood infected patients were diabetics as well.

D.M marked, in our study, an acceptable statically designed relation to the three swabs results (aureus nasal carriage) and blood infection; it might be due to immunity depression associated with diabetes mellitus.

Hemodialysis period

Hemodialysis period plays a role in blood infection occurrence; multiple studies pointed that the greater hemodialysis period becomes, the higher the blood infection probability gets. This case is because of catheter using seconded by aureus nasal carriage. Therefore, we had proceeded to divide hemodialysis periods be months then we studied the three swabs results and blood distribution in light of that division.

Table 11: evidences nasal carriage and blood infection distribution in respect Diabetes Mellitus

case	Total number	Diabetics number	Case percentage
Permanent Carriers	49	30	60
Intermittent Carriers	20	6	12
Non-Carriers	41	14	28
Total	110	50	100
Blood Infection	14	12	85.7

In brief, permanent aureus nasal carriage marked the highest proportion in (40.8%) in the group subjected to the minimal period of washing processes (< 13 months), while blood infection marked the maximal rate (50%) in group subjected to > 37 months.

Table 12: evidences nasal carriage and blood infection distribution in respect of Hemodialysis Period

Hemodialysis Period	Permanent Carriers number	Permanent carriage percentage	Blood infected number	Blood infected percentage
< 13	20	40,8	0	0
13-24	11	22.4	4	28.6
25-36	7	14.3	3	21.4
>37	11	22.4	7	50

According to Tab (14), hemodialysis period has an acceptable statistically designed relation with blood infection only. Our results were in concordant with Souly's ones (2011) despite of the difference in mean

hemodialysis period between us (25.5±21 in ours, 118.7±67 in his)

3. *Staphylococcus aureus* nasal carriage: This object represents our study target, blood infection in participated patients was investigated. *Staphylococcus*



aureus nasal carriage cases which correspond ,after each swab, with blood infection were identified. After crossing the three swabs results we obtained Tab(13):

- 85.8% of blood infections occurred in permanent nasal carriers

Only 7.1% of blood infections was associated with each of intermittent and no carriers.

It's worthy of mention that blood infection in study patients was caused by *Staphylococcus aureus*.

Table 13: distribution of blood infection in hemodialysed patients in comparison with *Staphylococcus aureus* nasal carriage

	Blood infected patients with permanent carriage	Blood infected patients with intermittent carriage	Blood infected patients with negative carriage
Total number of blood infected patients = 14	12	1	1
percentage	85.8	7.1	7.1

Staphylococcus aureus nasal carriage had a significant correlation connection with blood infection Tab (14). Our study results were in agreement with Von Eiff's (14) which concluded that a large proportion of *Staphylococcus aureus* blood infection in hemodialysed patients stems from endogen *Staphylococcus aureus*. i.e. Nasal carriage. So, *Staphylococcus aureus* nasal carriers are more prone to endogen blood infection.

Statistical Study

- **Spearman's Correlation connection study of the three swabs results and blood infection with risk factors:**

Each risk factor connection with the three swabs results was statistically studied in conformity with Spearman's test. Spearman's correlation coefficients among all variables were studied in view to estimate presence or absence of statistically designed correlation among these variables and to evaluate such correlation strength (if exist). The result were shown in Tab (14):

Table 14: results of correlation connection studied by Spearman

Risk Factors	The Three swabs results	Blood Infection
	P value	P value
Sex	NS	NS
Age	NS	NS
Central catheter infection	0.001***	0.001***
AV shunt infection	NS	0.001***
Diabetes Mellitus	0.007**	0.001***
Hemodialysis period	NS	0.001***
Aureus Nasal carriage	-	0.001***
Spearman's test NS: not significant *α=0.05, **α=0.01, ***α=0.001		

We observed from the previous table that *Staphylococcus aureus* nasal carriage, central catheter infection, Arterio-venous shunt, diabetes mellitus shunt and hemodialysis period have a significant statistically designed correlation with bacteraemia.

Staphylococcus aureus nasal carriage has a significant statistically designed correlation with central catheter infection and diabetes mellitus

Sex and age have no significant statistically designed correlation with neither

Staphylococcus aureus nasal neither carriage nor blood infection.

- Principal Component Analysis (PCA) study of multiple risk factors.

Risk factors were divided –on the basis of their importance- into three groups:

- 1) The first group was for two variants: *Staphylococcus aureus* nasal carriage followed by central catheter infection.



- 2) The second group was for age and diabetes mellitus variants.
- 3) The third was for hemodialysis period and AV shunt infection variants.

In other words, *Staphylococcus aureus* permanent nasal carriage and central catheter infection represent, in our study, the most risky factors for blood infection occurrence followed by age and diabetes mellitus, and lastly come hemodialysis period and AV shunt infection.

CONCLUSIONS

- 1) The nose represented an important warehouse for *Staphylococcus aureus*; therefore, carriers of these bacteria might play a role in its transmission and spreading in department and to other patients. Medical stuffs have an important role of *Staphylococcus aureus* spreading as well, because of direct contacts. This conclusion is based on the converting of many patient into permanent and intermittent carriers during the study.
- 2) Age, sex, hemodialysis period and AV shunt infection had no statistically designed correlation with *Staphylococcus aureus* nasal carriage; whereas central catheter infection had.
- 3) *Staphylococcus aureus* nasal carriage played an essential role among risk factors of blood infection occurrence, it marked a significant connection correlation with this infection which had associated clearly with permanent carriage.
- 4) *Staphylococcus aureus* nasal carriage was higher in diabetic hemodialysed patients than in others. There was a significant statistically designed correlation between *Staphylococcus aureus* nasal carriage and diabetes mellitus so diabetic patients are more susceptible to SAB occurrence; therefore preventive treatment by antibiotics may reduce infective mortality among them.
- 5) PCA concluded that permanent *Staphylococcus aureus* nasal carriage and central catheter infection represented the most risky factor of blood infection occurrence; therefore, it's ineluctable to deal with nasal carriage problem by rapid diagnosis and elimination of these bacteria in order to prevent their infections complications.

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Source of Support: Nil, Conflict of Interest: None.

