Cardiovascular Comorbidities, Inflammation and Serum Albumin Levels in a Group of Hemodialysis Patients

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Cardiovascular comorbidities have a high rate of prevalence in the chornically hemodialysed patient. The link between these two affections is due to several factors which have a major role in the onset of cardiovascular diseases, such as hypervolemia, nutritional disorders, anemia, hyperuricemia, bone mineral disorders, hyperlipidemia, atherosclerosis. There is also a tight connection between chronic inflammation and cardiovascular diseases in the chronically hemodialysed patient.

Keywords: hemodialysis, cardiovascular comorbidities, albumin, chronic inflammation

The tight link between CKD and cardiovascular disease has a major importance due to the scaling of mortality [1]. Another factor which influences the patient's survival rate, besides the inflammatory status and the presence of cardiovascular complications, is their nutritional status. There is an inverse proportionality relationship between the latter and the former two. In other words, an elevated degree of inflammation and cardiovascular disease lead to a poor nutritional status [2]. We would like to study the connection between cardiovascular comorbidities, inflammatory status, nutritional status and CKD on a group of 123 hemodialysis patients.

Experimental part

We made a study on a group of 123 hemodialysis patients. The inclusion criteria were patient age over 18, hemodialysis duration longer than 6 months. The exclusion criterion was an active neoplasia.

All of the pacients included in this study have signed a participation agreement form. Each of the participants had a study chart in which the socio-demographic characteristics (age, gender, area of origin), as well as their pathological background were included.

Because the patients belonged to several age groups (18 to 76 years old), the study group was divided based on age into several subgroups: ages 18-27(2 patients), ages 28-49 (24 patients), ages 50-69(82 patients), ages 70-79(15 patients). The age intervals are large because, in order to obtain statistically significant data, we needed each subgroup to contain a large number of patients. The subject database has been redacted in Microsoft Excel 2013 and the data has been statistically analysed with several tests: COUNTIFS Multiple criteria, Data Analysis: Anova, Correlation.

Results and discussions

Out of the 123 patients, 44 were female and 79 were male. 39 patients came from a rural environment while 84 came from an urban environment. Based on the age groups, we have decided to divide the study group into 4 age-based subgroups: ages 18-27, ages 28-49, ages 50-69, ages 70 and over.

From the table 1 we conclude that most pacients (82) belong to the ages 50-69 subgroup. The second largest subgroup is ages 28-49, containing 24 pacients and the third largest is represented by the ages 70 and over subgroup which contains 17 patients. The smallest study group is the ages 18-27 group which only contains 2 patients.

For a better description of the study group we have analysed the patient's gender and area of origin within each age subgroup (table 2).

The Ages 18-27 subgroup included 2 male patients, one of urban and one of rural area of origin. The Ages 28-49 subgroup included 8 female patients and 16 male patients. Within this subgroup 9 subjects were of rural and 15

	Age interval			
	Ages 18-27	Ages 28-49	Ages 50-69	Ages 70 and over
Number of patients	2	24	82	15

Table 1
AGE-BASED STUDY GROUP DISTRIBUTION

	Female patients		Male patients	
	Rural area of origin	Urban area of origin	Rural area of origin	Urban area of origin
Ages 18-27	0	0	1	1
Ages 28-49	3	5	6	10
Ages 50-69	13	21	14	34
Ages 70 and over	0	2	2	11

Table 2
GENDER AND AREA OF ORIGIN SUBJECT DISTRIBUTION

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subjects were of urban area of origin. 82 of the 123 pacients were included into the ages 50-69 subgroup. Similarly to the previous 2 subgroups, there was a male predominance (48 patients) compared to female (34 patients). Within this subgroup, 27 patients were of rural origin while 55 patients were of urban origin. 7 Of these patients are of ages 70 or above. Two of them are female and of urban origin. Out of the 13 male patients, 2 of them are of rural origin, while 11 of them are of urban origin.

Within this study we wish to assess the influence of cardiovascular comorbidities and chronic inflammation on the serum albumin levels of hemodialysis patients. We have first studied the distriution of cardiovascular comorbidities: hypertension and heart failure: 87% of the patients (107 patients) included in this study suffer from hypertension while only 16% of these suffer from heart failure (table 3).

On a deeper analysis of the distribution of hypertension and heart failure within the studied group, we noticed that most of the subjects suffer from hypertension, but do not associate heart failure(72%). Only 4 patients had heart failure without hypertension (3%). 12 patients (10%) did not have either one of the diseases., while both of them were present at 18 patients (15%) of the study group (fig. 1).

Starting from the general distribution of cardiovascular comorbidities within the subjects of our study group, we wish to point out that there are differences within the age subgroups (ages 18-27, ages 28-49, ages 50-69, ages 70 and over). We have also studied the distribution of cardiovascular comorbidities within each subgroup regarding the patients gender and area of origin (table 4).

We have decided to continue studying the lowest, highest and average serum C-reactive protein and albumin levels. This approach comes from the fact that a high level of inflammation is associated with a higher chance of

	Suffer from cardiovascular comorbidities	Do not suffer from cardiovascular comorbidities
Hypertension	107 patients (87%)	16 patients (13%)
Heart filure	20 patients (16%)	103 patients (84%)

Table 3
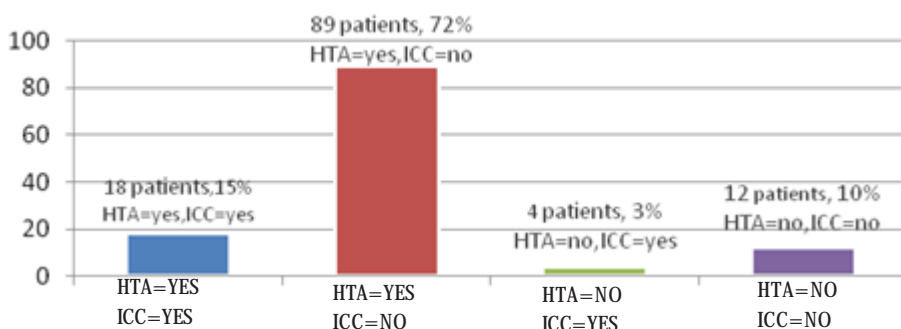THE DISTRIBUTION OF HYPERTENSION AND HEART FAILURE WITHIN THE STUDIED GROUP

Fig. 1. The distribution of hypertension and heart failure within the studied group

Table 4
THE DISTRIBUTION OF CARDIOVASCULAR COMORBIDITIES REGARDING PATIENT AGE, GENDER AND AREA OF ORIGIN

Patient gender	Male patients				Female patients			
Age subgroup	ages 18-27	ages 28-49	ages 50-69	ages 70 and over	ages 18-27	ages 28-49	ages 50-69	ages 70 and over
Number of hypertensive patients	1	14	43	9	0	6	32	2
Number of patients with heart failure	0	1	10	2	0	2	7	0
Number of patients with both comorbidities	0	1	10	1	0	1	5	0

Table 5
THE MEAN SERUM ALBUMIN AND CRP LEVELS BASED ON CARDIOVASCULAR COMORBIDITIES

Serum levels	CRP								Albumin							
Subgroup	ages 18-27		ages 28-49		ages 50-69		ages 70 and over		ages 18-27		ages 28-49		ages 50-69		ages 70 and over	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Number of patients with heart failure	-	0.12	0.27	0.54	1.19	1.66	0,97	1.53	-	4.29	4.25	4.27	4.07	4.05	4.25	4.09
Number of hypertensive patients	-	-	0.45	1.43	1.53	0.56	-	2..25	-	-	4.42	3.92	4.05	3.98	-	4.23
Number of patients with both comorbidities	-	-	0.4	1.43	1.51	0.65	-	2.97	-	-	4.42	3.92	4.04	3.98	-	3.97

cardiovascular events and it also influences the patient's nutritional status [3-5] (table 5).

We continued to analyse each patient subgroup to study the influence of cardiac commorbidities on serum CRP and albumin levels (table 6).

Noticing the differences regarding the patients gender, we wished to further assess the how it influences the two laboratory tests within each subgroup of patients using the η and η^2 tests (table 7).

Furthermore, we have assessed the relationship between serum albumin and CRP levels as well as the influence of CRP levels on serum albumin levels within each patient subgroup (table 8, 9).

Our studies' results have been checked for their statistic significance (table 10-13).

We have approached the data gathered by this study as a whole and have compared them to the data available in specialized literature.

We observed a male predominance in our study group, this being in agreement to the data available in specialized literature, where it is stated the the male geneder in a risk factor for CKD [6] and that there is a male predominance within end-stage CKD patients [7].

We observed that most patients were of urban are of origin- explainable through a greater access to medical services (table 2) [8]. In contrast, the low socioeconomic status of the rural are of origin patient group contributes to a low medical addressability [9,10].

Our largest age-based subgroup was that of Ages 50-69 (82 patients, table 1). This is due to the fact that CKD prevalence increases with age [11-13].

Most of the patients were hypertensive (87% , table 3). This confirms the data that hypertension has a high prevalence among hemodialysis patients [14]. Within the study group we have identified 16% of the subjects(table 3) to suffer from heart failure.

The incidence of hypertension is assumed to be around 80% in hemodialysis patients, while around 15% of them have some degrees of heart failure at the start of the hemodialysis [15].

Analyzing the serum albumin and CRP levels by gender, female patients belonging to the subgroup Ages 28-49 have a higher mean serum albumin levels, while the lowest values belonged to the subgroup Ages 50-69. Regarding male patients, the highest mean serum albumin level was present at the subgroup ages 18-27, while the lowest was present at the subgroup ages 28-49.

Regarding gender, male patients belonging to the subgroup Ages 18-27 had the lowest serum CRP values, while female patients belonging to the subgroup Ages 28-49 had the lowest serum CRP values. The highest serum CRP values among male patients was in the subgroup Ages 70 and over, while among female patients within the subgroup Ages 50-69.

We have studied the relationship between the cardiovascular comorbidities, inflammation levels and patient nutritional status within each patient subgroup. Analyzing the mean serum values of these lab test by cardiovascular comorbidities, the lowest serum albumin values were reported for male patients belonging to the subgroup ages 28-49 which suffer from either hypertension or heart failure. The highest serum albumin values were reported in female patients belonging to the same age subgroup who do not have any of the two comorbidities.

Regarding mean serum CRP values, the lowest value was attributed to male patients ages 18-27 suffering from heart failure. The highest mean serum CRP value belonged to patient of ages 70 and over suffering from hypertension an heart failure.

Judging by our results we can state that within the subgroup of patients Ages 18-27, serum albumin levels, compared to serum CRP levels, are more influenced by the presence of the above mentioned cardiac comorbidities.

Based on our results we can state that within the subgroup Ages 50-69 serum album levels are strongly influenced by the presence of the above mentioned cardiac comorbidities. In other words, serum albumin levels maintain their sensitivity towards cardiac comorbidities. On the other hand, unlike the patient subgroup Ages 28-49, within this subgroup (Ages 50-69), serum CRP levels is far more influenced by the presence of the above mentioned cardiac comorbidities. This points out the fact that among patients ages 50-69 the serum CRP level is

Table 6
THE INFLUENCE OF CARDIAC COMMORBIDITIES ON SERUM CRP AND ALBUMIN LEVELS

	Heart failure – serum albumin levels				Hypertension – serum albumin levels				Heart failure – serum CRP levels				Hypertension – serum CRP levels			
Subgroup	18-27 ani	28-49 ani	50-69 ani	>70 ani	18-27 ani	28-49 ani	50-69 ani	>70 ani	18-27 ani	28-49 ani	50-69 ani	>70 ani	18-27 ani	28-49 ani	50-69 ani	>70 ani
η^2	0.997	0.980	0.967	0.976	0.960	0.967	0.967	0.955	0.399	0.187	0.281	0.391	0.086	0.229	0.069	0.113
η	0.998	0.990	0.983	0.988	0.980	0.983	0.983	0.977	0.631	0.433	0.530	0.625	0.294	0.478	0.263	0.337

Subgroup	Ages 18-27		Ages 28-49		Ages 50-69		Ages >70 and over	
	CRP	Albumin	CRP	Albumin	CRP	Albumin	CRP	Albumin
η^2	0.399	0.997	0.007	0.962	0.202	0.951	0.391	0.976
η	0.631	0.998	0.084	0.981	0.450	0.975	0.625	0.988

Table 7
THE GENDER INFLUENCE ON SERUM ALBUMIN AND CRP LEVELS

	Serum CRP levels - Serum albumin levels			
	Ages 18-27	Ages 28-49	Ages 50-69	Ages >70 and over
η^2	0.891	0.976	0.649	0.816
η	0.944	0.988	0.805	0.903

Table 8
THE RELATIONSHIP BETWEEN THE SERUM ALBUMIN AND CRP LEVELS WITHIN THE STUDY GROUP

	Albumin				CRP			
	Ages 18-27	Ages 28-49	Ages 50-69	Ages >70 and over	Ages 18-27	Ages 28-49	Ages 50-69	Ages >70 and over
Albumin	-	1	1	1	-	-	-	-
CRP	-	-0.181	-0.215	0.150	-	1	1	1

Table 9
THE INFLUENCE OF CRP LEVELS ON SERUM ALBUMIN LEVELS WITHIN THE STUDY GROUP

Heart failure – *Serum albumin levels*			
Subgroup	*Ages 18-27*	*Ages 28-49*	*Ages 50-69*	*Ages >70 and over*
p-value	0.00131017 (p<0.05)	6.523×10^{-41} (p<0.05)	5.8×10^{-122} (p<0.05)	1.94×10^{-24} (p<0.05)

Hypertension – *Serum albumin levels*			
Subgroup	*Ages 18-27*	*Ages 28-49*	*Ages 50-69*	*Ages >70 and over*
p-value	0.019953171 (p<0.05)	8.8×10^{-36} (p<0.05)	2.5×10^{-122} (p<0.05)	$1,78 \times 10^{-20}$ (p<0.05)

Heart failure – Serum *CRP levels*			
Subgroup	*Ages 18-27*	*Ages 28-49*	*Ages 50-69*	*Ages >70 and over*
p-value	0.3681 (p>0.05)	0.00209 (p<0.05)	2.7×10^{-13} (p<0.05)	0.00022 (p<0.05)

Hypertension – *Serum CRP levels*			
Subgroup	*Ages 18-27*	*Ages 28-49*	*Ages 50-69*	*Ages >70 and over*
p-value	0.705 (p>0.05)	0.000573604 (p<0.05)	0.000663241 (p<0.05)	0.068362 (p>0.05)

more sensible to the presence of cardiac comorbidities. Unlike the previous subgroup (Ages 28-49), at a rise of 1% of serum CRP levels, the scaling of serum albumin levels is smaller. In other words, serum albumin levels will drop by 21.5% if serum CRP levels rise by 1%. This suggests that there are other inflammation factors that influence the serum albumin levels within this subgroup of patients.

Regarding the patient subgroup Ages 70 and over we noticed that serum albumin levels is influenced in similar manner to the other patient subgroups by the cardiac comorbidities. The major difference in this subgroup is that the serum CRP levels are more strongly influenced by the presence of cardiac comorbidities.

Regarding the relationship between hypertension and serum CRP levels within the studied subgroups, we can conclude that within the subgroup Ages 70 and over, due to the statistically non-significant p-value of 0.068 (higher than 0.05) hypertension cannot be taken into account as a factor that influences serum CRP and albumin values.

Likewise, in the Ages 18-27 subgroup, the cardiovascular comorbidities cannot be taken into account as an influential factor of the serum CRP and albumin values: (p-value 0.3681 for hypertension/CRP, p-value 0.705 for heart failure/CRP).

We have also observed that the greatest influence of hypertension on serum albumin values occurs in the subgroups Ages 50-69 and 70 and over.

In the subgroup Ages 28-49, serum CRP levels greatly influence the nutritional status of the hemodialysis patient. For patients above this age, its influence on serum albumin is lower, about half as much compared to the previous subgroup.

By analyzing the results obtained by this study we conclude that serum albumin levels show an altering trend influenced by the aging of the patients. Its levels were nor greatly destabilized by the other altering factors mentioned in this study (cardiovascular comorbidities, chronic inflammation). CRP levels do not represent an important influential factor on serum albumin levels for the Ages 70-79 subgroup.

Based on the results from table 7 we can state that the gender influence on serum CRP and albumin levels differs significantly within the four subgroups. Within all subgroups, gender is a significant influential factor on serum albumin levels, but within the Ages 18-27 and 70 and over subgroups, it has a greater statistical influence on CRP levels.

Age and gender influences on serum albumin levels have been researched in other studies. Among these characteristics, Diabetes mellitus has a powerful influence on serum albumin levels [16]. The association between chronic inflammation and the nutritional status of the hemodialysis patient is present in other studies. So, due to the high catabolic rate attributed to chronic inflammation, serum albumin levels drop. Studies also show that albumin synthesis rises with increased plasmatic volume [17].

Conclusions

Chronic inflammation plays a major role in determining the nutritional status of hemodialysis patients ages 28-49. Also, for patients aged 50 or above, there are other contributing factors to the serum albumin levels, alongside chronic inflammation, which may become subjects for future research.

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