

# Oral Health conditions in hemodialysis Patients

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**Abstract**— *Objectives: This study aimed to assess oral health status and self-perceived oral health in hemodialysis (HD) patients.*

*Materials and Methods: The decayed, missing and filled teeth (DMFT) index and the community periodontal (CPI) index were used to assess oral health status and self-perceived oral health in 128 HD patients. Salivary flow (SF) and pH were also measured.*

*Results: Mean age was 56.2±17.1 years and mean DMFT was 23±9.14. There were 41 (32%) edentulous participants and 81 (94.3%) non-edentulous participants presented periodontal alterations. SF was normal ( $\geq 1.0$  ml/min) in five (3.9%) participants before HD and in 17 (13.3%) participants after HD. SF was very low ( $\leq 0.3$  ml/min) in 60 (46.9%) participants before HD and in 26 (20.3%) participants after HD. The difference in SF before ( $0.39 \pm 0.28$  ml/min) and after ( $0.60 \pm 0.34$  ml/min) HD was significant ( $p < 0.001$ ). There was a negative correlation between salivary flow and age before ( $r = -0.188$ ,  $p = 0.033$ ) and after ( $r = -0.261$ ,  $p = 0.003$ ) HD.*

*Conclusions: Despite the increase in salivary flow after HD sessions, the rates were still below the normal levels, thus indicating the need for special care.*

*Clinical Relevance: Our findings show that the oral health care professional should provide preventive and restorative treatment to HD patients and should be included in the multiprofessional health team managing the care of HD patients.*

**Keywords**— *Salivary Flow. Oral Health. Hemodialysis. Dentistry.*

## I. INTRODUCTION

Chronic kidney disease (CKD) is a progressive condition characterized by a gradual loss of kidney function over time. Its diagnosis is made on the basis of decreased glomerular filtration rate or markers of kidney damage, or both, of at least 3 months duration [1]. Early recognition and intervention are essential to slowing disease progression, maintaining quality of life, and improving outcomes [2].

According to a survey of chronic kidney disease patients, there were 122,825 dialysis patients in Brazil in 2016, with a dialysis treatment rate of 596 patients per million inhabitants and a mean annual increase in the number of dialysis patients of 6.3% over the last five years.

Additionally, the survey revealed that 57% of the patients were men, 87.5% were aged 65 and older, 41% presented diabetic nephropathy, and 92% were hemodialysis (HD) patients [3]. However, many HD patients and the medical staff responsible for their care are unaware of oral health conditions and changes associated with HD [4, 5].

Hemodialysis is the treatment used to replace kidney function. It is a complex process that requires a multidisciplinary approach in order to ensure a more comprehensive patient management [6]. Special attention should be given to the oral health of HD patients, not only because of oral conditions and specific diseases, but also because of various systemic manifestations commonly associated with CKD [7, 8]. Therefore, the control of the oral and systemic manifestations to which these patients

are very susceptible should be part of their treatment. Failure to do so can lead to the onset of infectious diseases that interfere with the treatment and/or even delay kidney transplant [9].

The saliva, which plays a major role in digesting food and in preserving the integrity of oral tissues, can be negatively affected in patients with kidney failure. However, few studies have evaluated salivary changes and composition in patients undergoing HD [10, 11]. Research has shown that fluid intake restriction, use of different types of drugs, systemic disorders and radiation therapy are specific risk factors for changes in salivary pH and flow [12].

Although HD therapy prevents patients from visiting the dentist, it is estimated that 90% of patients with CKD undergoing HD have some oral health problem [13, 14]. The most common oral health problems in this population are gingival inflammation, increased periodontal probing depth, xerostomia, halitosis and dental caries [5, 15, 16]. Moreover, many patients do not perceive the need for preventive dental care, and systematic oral health education programs targeted at HD patients have not been described in the literature [17, 18].

Thus, considering the hypothesis that HD can modify the oral environment in the long term and immediately after the treatment session, understanding the changes in the salivary flow and the oral health conditions related to HD may improve healthcare professionals' decision-making regarding treatment protocols for these patients. Given that, the present study aimed to assess the oral health status, including dental problems, soft tissue and salivary (flow and pH) changes, and the self-perceived oral health of patients undergoing hemodialysis.

## II. MATERIALS AND METHODS

A cross-sectional study was conducted in two hemodialysis clinics located in a capital city in Northeastern Brazil. Data were collected in 2013 and these clinics were selected for being reference hemodialysis treatment centers.

The research was approved by the Research Ethics Committee of the University of Fortaleza, Brazil, under Approval No. 150.713. All the participants were aware of the study protocol and gave their written informed consent prior to participation in the research. Eligible patients were randomly assigned for enrollment and clinical decisions were not controlled by the study protocol. Inclusion criteria were: patients undergoing HD in the hemodialysis clinics selected for the research who could answer the interview questions. Patients under 18 years of age were excluded from the study.

Data were collected in three phases by a single researcher (PLPM) who was trained by a co-author (ABL) for phase two and calibrated against a gold standard examiner (MVLS) for phase three (intra and inter kappa values were  $>0.8$ ). In the first phase, an interview was conducted to obtain information on patients' self-perceived oral health status. The questionnaire was adapted from a World Health Organization's Oral Health Survey [19] and included questions regarding oral pain, dry mouth, difficulty swallowing, problems with the taste of food, and burning mouth sensation. Additionally, data on participants' general health and socioeconomic status were collected from medical records.

The second phase was designed to assess salivary flow and pH. The participants were aware of the required abstinence from smoking, drinking, eating and tooth brushing at least one hour prior to saliva collection. This phase took place at two moments: immediately before and immediately after the hemodialysis session. Salivary pH was measured using pH indicator strips (pH 0-14; Merck®, Darmstadt, Germany). The patient was asked to remain with the mouth open and a strip was placed on the tongue for one minute. After removing the strip, the color change was compared with the color chart and recorded in the patient's file [20].

The analysis of salivary flow was performed with saliva collected after stimulation. This procedure is useful for allowing saliva collection from major and minor salivary glands [21]. Patients were asked to chew a piece of sterile rubber sheet (3 cm x 2 cm), which is used in dental procedures, for one minute. The rubber sheet was tied to dental floss to prevent swallowing. The first sample of saliva collected immediately after stimulation was discarded. After that, the patient was asked to spit into a glass container graduated in milliliters for five minutes and the amount of saliva collected was divided by the time the collection process lasted, thus providing the salivary flow rate in mL/min [22]. Stimulated salivary flow rates that ranged 1-3 mL/minute were considered normal for adults. Hyposalivation occurred when the rate was below 1 mL/minute [23, 24]. Stimulated whole saliva flow rates below 0.7 mL/minute are within the lower range of output and suggest salivary hypofunction [25]. Therefore, the percentage of patients with salivary flow rates below 0.7 mL/min was also calculated and studied.

The last phase of data collection consisted of an oral examination before the hemodialysis session using the following sterilized instruments: flat mouth mirror (size No.5) and the WHO-621 periodontal probe, which has a ball end of 0.5mm diameter and a first colored band at 3.5–5.5mm. Assessment of oral health and oral mucosal status was carried out with the patient sitting on a chair under

artificial light. Periodontal status was assessed using the Community Periodontal Index (CPI) and dental caries was assessed using the Decayed, Missing and Filled Teeth Index (DMFT). Both indices used parameters and forms adapted from the World Health Organization Oral Health Survey [19]. Oral examination was performed, and the data were recorded in about 15-20 minutes.

The data were analyzed using SPSS for Windows (version 19.0, SPSS Inc., Chicago, IL, USA) with a significance level set at 5% ( $p < 0.05$ ). Pearson's correlation test, Fisher's exact test and one-way ANOVA were used to analyze the data and check for correlations between the variables. Continuous variables were described as median and mean  $\pm$  standard deviation (SD) and categorical variables were described as frequencies and percentages.

### III. RESULTS

There were 155 eligible patients in the HD clinics, but 16 were excluded after application of the exclusion criteria and 11 refused to participate in the research. Thus, the final sample consisted of 128 patients. Of these, 92 (72.7%) were originally from the state's capital and 36 (27.3%) were from smaller cities.

The age of the participants ranged 20 to 91 years, with a mean age of  $56.2 \pm 17.1$  years and a median age of 59 years. Table 1 shows the socioeconomic status of the participants in the two centers. The patients were predominantly men ( $n=66$ ; 51.6%), married ( $n=79$ ; 61.7%), retired ( $n=64$ ; 50%), had primary education ( $n=51$ ; 39.8%) and received up to one minimum wage ( $n=88$ ; 68.8%).

The information collected from the patients' medical records revealed that the disease that more often caused CKD was hypertension ( $n=96$ ; 75.1%), followed by diabetes ( $n=47$ ; 36.8%). Other diseases directly related to kidney disorders, such as glomerulonephritis and kidney stone, accounted for 26 cases (20.3%).

Table 2 shows patient's self-reported oral discomfort, with dry mouth being the patient's major complaint, although it did not significantly correlate with salivary flow before or after hemodialysis ( $p=0.342$  and  $p=0.404$ , respectively).

Table 3 depicts the DMFT and salivary flow and pH results in relation to the participants' age. Periodontal status was assessed in 87 patients only because the others were edentulous ( $n=41$ ; 32%). Of these patients, 82 (94.3%) had some type of health problem. No correlation was found between periodontal problem and the duration of treatment ( $r=0.042$ ,  $p=0.702$ ; one-way ANOVA  $p=0.537$ ). Changes in soft tissue were detected in 21.9% ( $n=28$ ) of the patients examined. Stomatitis ( $n=14$ ; 10.9%), ulcers ( $n=6$ ; 4.8%),

cheilitis ( $n=4$ ; 3.1%) and candidiasis ( $n=4$ ; 3.1%) were observed. The mean DMFT was  $23.0 \pm 9.15$ , with a mean of  $8.98 \pm 9.12$  decayed,  $18.95 \pm 11.72$  missing, and  $1.66 \pm 3.44$  filled teeth. The need for rehabilitation with dental prosthesis was observed in 75.8% ( $n=97$ ) of the patients.

Table 4 shows that salivary flow rate before the hemodialysis session ranged 0.10 mL/min to 1.80 mL/min and some patients exhibited a salivary flow rate below 0.7 mL/min. After the session, salivary flow rate ranged 0.10 to 2.0 mL/min, with some patients exhibiting a salivary flow rate below 0.7 mL/min. Salivary flow was normal ( $\geq 1.0$  mL/min) in five (3.9%) patients before the hemodialysis session and in 17 (13.3%) patients after the hemodialysis session. Extremely low salivary flow rates ( $\leq 0.3$  mL/min) were found in 60 (46.9%) patients before the HD session and in 26 (20.3%) after the HD session.

Salivary flow differed significantly before and after the hemodialysis session and it was measured using continuous and categorical scales. Increased salivary flow was observed in 106 participants (82.8%) and salivary pH was higher before the HD session ( $\text{pH } 7.18 \pm 0.87$ ) compared with the pH after the HD session ( $\text{pH } 6.82 \pm 0.78$ ), as shown in Table 4.

Table 5 presents the significant correlations of changes in salivary flow before and after hemodialysis with age, DMFT and pH. No correlation was observed between duration of hemodialysis treatment and periodontal problems measured by the CPI ( $r_s=0.039$ ,  $p=0.720$ ) even when comparing the duration of hemodialysis treatment between different periodontal problems groups (one-way ANOVA,  $p=0.537$ ).

When the correlation between salivary flow and age was analyzed, a negative relationship was found (age and salivary flow before hemodialysis:  $r=-0.188$ ,  $p=0.033$ ; age and salivary flow after hemodialysis:  $r=-0.261$ ,  $p=0.003$ ; age and salivary flow difference:  $r=-0.208$ ,  $r=0.019$ ), showing that not only salivary flow is decreased with age, but also that the increase of salivary flow after hemodialysis is decreased with age.

### IV. DISCUSSION

Patients undergoing hemodialysis (HD) are vulnerable to infection and the oral cavity is a potential source of infection. Therefore, it is important to monitor HD patients' oral health (including salivary flow and sources of infection, such as dental cavities and periodontal problems) and implement oral health preventive measures.

In the general population, the association between salivary flow and age is unclear. While some clinical studies have shown a reduction in salivary flow with age [26,27], other

studies have not reported such association [28, 29]. However, saliva is a robust indicator for monitoring health status and for disease surveillance as it is a noninvasive, cost-effective and highly sensitive diagnostic approach that correlates with blood samples [11]. In our study, the association between salivary flow and age revealed that not only salivary flow is decreased with age, but also the improvement of salivary flow after HD proportionally decreased with age. The saliva plays a major role in oral health and older adults undergoing HD are at increased risk for oral diseases [22]. Therefore, this population group needs a higher standard of care to prevent systemic complications caused by oral health problems.

It should be noted that HD patients also present with general and oral health problems (e.g., xerostomia, drug idiosyncrasy, drug side effect) that affect their oral health and quality of life [6, 30]. A decrease in salivary flow may result in a significant decline in oral health defense and thus lead to discomfort and clinical problems, such as caries, altered taste, halitosis, and increased susceptibility to infections [22]. Therefore, the dentist should be part of the HD care team so that patients are carefully managed. However, the dentist must have a wide knowledge of HD treatment to better understand how HD can modify oral health status. Some factors are essential for the dental treatment of hemodialysis patients, particularly the evaluation of medical history, medication profile and radiographic and laboratory data [31]. The restorative dentistry treatment should preferably be performed prior to the first HD session [32]. However, if this is not possible, dental treatment should be avoided on dialysis days in order to avoid the interference of the use of local anesthesia with adrenaline, which will demand special care from the health care provider [33].

Patients' low socioeconomic status, as observed in the present study, can increase their vulnerability to health complications. Researchers emphasize that oral diseases are still a major public health problem in high-income countries and a growing problem in many low- and middle-income countries. Socioeconomically disadvantaged groups are at increased risk for these problems and often do not receive adequate oral health care. In addition, oral disease prevention is usually neglected in public health services, which, once again, puts patients undergoing HD in public services at greater risk for oral health problems [34].

The sialometry showed a significant increase in salivary flow after the HD session ( $p < 0.001$ ). However, such increase was not enough to place the majority of patients undergoing HD in the normal range of salivary flow seen in healthy patients (0.7 to 1.0 mL/min) [35, 36].

These findings are corroborated by studies performed in India and Brazil [10, 37]. Salivary flow correlated with the DMFT index, thus indicating that patients' reduced salivary flow leads to a greater prevalence of dental caries. Reduced salivary flow compromises taste and swallowing and increases the risk of fungal and bacterial infections [38]. It is important to understand that saliva is a fluid with many functions, such as oral digestion, oral mucosa lubrication, maintenance of the ecological balance in the oral cavity, antimicrobial activity and effective protection of teeth integrity by maintaining pH in the oral cavity [39]. Control of oral infections may be hampered if salivary flow and/or its function is altered or reduced, which will decrease its lubricating effect and therefore its capacity to maintain the integrity of oral structures [40].

The association between risk factors shared by various disabling conditions requires interventions by national health programs, which can be effective in improving the oral health status and quality of life of population groups [34]. Oral health issues need to be addressed by the public health system, especially when socioeconomically disadvantaged population groups are involved. Given that, it should be noted that the HD patients analyzed in the present study are faced with a double burden – the disease (and all its related problems) and the difficulty to access oral health treatment, which is commonly observed in population groups of low socioeconomic status. A multinational study conducted in France, Hungary, Italy, Poland, Portugal, and Spain suggested that the stress deriving from the treatment itself reduces the quality of life and self-care capacity, resulting in worse oral hygiene – although the multifactorial nature of oral diseases is also acknowledged [41, 42].

In our study, dental caries was evaluated by the DMFT index. The findings regarding present (decayed teeth) and past (filled and missing teeth) experiences suggest a poor dental status in the study population. This situation may be indirectly influenced by the kidney disease and by socioeconomic and cultural factors, especially with regard to missing teeth, for which the mean was  $18.9 \pm 11.7$  teeth. Similar findings regarding edentulism have been reported in another study [43], and the last national oral health survey in Brazil showed adults with a mean of 7.4 missing teeth [44].

Our data support other findings that chronic kidney disease (CKD) may have significant effects on periodontal health. Although there was no correlation between PCI and HD treatment duration as reported in the literature, changes such as increased dental calculus, gingival inflammation, probing depth and attachment loss were also detected [45, 46]. Given that, treatment and control of



periodontal disease should be started in the early stages of CKD due to a bidirectional association of cause and effect, with systemic impact of inflammation/infection and immune response [47, 48].

Although the need for such care is acknowledged, access to dental care in the past year was reported only by 32% of the patients in our study. A similar study of 147 hemodialysis patients in Canada showed that 41% of the participants had undergone dental treatment in the previous year [33]. These findings reinforce the need for greater provision of primary and preventive care by oral health professionals in order to reduce infection and other complications that contribute to increased morbidity and mortality, such as atherosclerotic complications and future transplant rejection [10, 47, 49].

The present study showed oral and salivary changes in patients undergoing HD. Despite the absence of correlation between salivary flow and oral discomfort, salivary flow (before and after HD) was negatively correlated with age and DMFT and positively correlated with salivary pH. Nevertheless, a high percentage of participants reported some type of oral discomfort. Awareness of the oral health of HD patients is an important strategy to alert dentists about preventive measures aiming to minimize problems that might impair general health status. Oral and salivary changes in HD patients suggest a need for special attention to oral health treatment [10].

Despite not being the main objective of our study, our findings demonstrated the need to include the dentist in the multidisciplinary team responsible for patients undergoing HD. The inclusion of the dentist in the multidisciplinary team should be discussed in HD centers around the world, particularly in public facilities and in facilities that serve patients of low socioeconomic status.

The present study has some limitations. The study did not include a control group and did not consider that other external factors may influence oral health, salivary flow and pH measures. Although the findings cannot be generalized to all the patients, changes in the oral health status were found in patients undergoing HD. Therefore, further studies should be carried out to strengthen research in this field.

Our findings demonstrated that HD patients present with dental and periodontal problems. There was a high prevalence of moderate and severe periodontal disease and a high DMFT index, with a predominance of missing teeth. An association between salivary flow and age was observed, showing that not only salivary flow is decreased with age, but also that the improvement of salivary flow after HD proportionally decreased with age. Despite an

increase in salivary flow after the hemodialysis session, its values were still below the normal levels. The oral health care professional should provide preventive and restorative treatment to HD patients and should be included in the multiprofessional health team managing the care of HD patients.

## V. COMPLIANCE WITH ETHICAL STANDARDS

**Conflict of Interest:** Paulo Leonardo Ponte Marques declares that he has no conflict of interest. Maria Vieira de Lima Saintrain declares that she has no conflict of interest. Alexandre Braga Libório declares that he has no conflict of interest. Lucianna Leite Pequeno declares that she has no conflict of interest. Anya Pimentel Gomes Fernandes Vieira-Meyer declares that she has no conflict of interest.

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**Ethical approval:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the Research Ethics Committee of the University of Fortaleza (Approval No. 150.713) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent:** Informed consent was obtained from all individual participants included in the study.

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Table 1. Socioeconomic characteristics of the study participants.

Variable	Frequency (N=128)	%
<b>Gender</b>		
Women	62	48.4
Men	66	51.6
<b>Marital status</b>		
Single	25	19.5
Married	79	61.7
Divorced	5	3.9
Widowed	19	14.8
<b>Schooling</b>		
Illiterate	19	14.8
Literate	13	10.2
Primaryeducation	51	39.8
Secondaryeducation	32	25.0
Highereducation	13	10.2
<b>Occupation</b>		
Employed	05	3.9
Unemployed	16	12.5
Social Security	43	33.6

Retired	64	50.0
<b>Income</b>		
No income	16	12.5
1 minimum wage	88	68.8
>1 minimum wage	24	18.8

Table 2. Oral discomfort reported by the participants and its correlation with salivary flow before and after hemodialysis.

Variable	Salivary flow before Hemodialysis			Salivary flow after hemodialysis		
	Low	Normal	pvalue*	Low	Normal	pvalue*
<b>Mouthpain</b>						
Yes	11	0	0.264	10	01	0.079
No	103	14		77	40	
<b>Toothpain</b>						
Yes	16	04	0.152	12	08	0.280
No	98	10		75	33	
<b>Drymouth</b>						
Yes	60	06	0.342	46	20	0.404
No	54	08		41	21	
<b>Difficulty to swallow</b>						
Yes	22	01	0.237	16	07	0.534
No	92	13		71	34	
<b>Problems with taste of food</b>						
Yes	18	-	0.106	13	05	0.452
No	96	14		74	36	
<b>Burning mouth sensation</b>						
Yes	05	02	0.170	04	03	0.399
No	109	12		83	38	

\*Fisher's Exact test.



Table 3: Descriptive DMFT (divided by components) and salivary pH and flow by age group.

	35-44 years old (n=31)				45-59 years old (n=34)				60+ years old (n=63)				Total (n=128)			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
DMFT	0	26	11.26	6.46	10	32	23.47	6.81	7	32	28.52	5.14	0	32	23.00	9.15
Healthy teeth	6	32	20.68	6.43	0	22	8.56	6.81	0	25	3.46	5.13	0	32	8.98	9.12
Decayed teeth	0	24	3.52	4.81	0	16	3.18	4.71	0	11	1.43	2.45	0	24	2.40	3.89
Missing teeth	0	14	4.29	4.16	3	32	18.56	10.01	3	32	26.37	7.49	0	32	18.95	11.72
Filled teeth	0	17	3.45	3.96	0	14	1.74	3.43	0	21	0.75	2.81	0	21	1.66	3.44
pH before HD	6	8	7.58	0.56	6	8	7.24	0.78	5	9	6.95	0.97	5	9	7.18	0.87
pH after HD	6	8	7.06	0.73	6	8	6.82	0.67	4	8	6.70	0.84	4	8	6.82	0.78
pH difference	-1	2	0.52	0.77	-1	2	0.41	0.99	-1	3	0.25	0.82	-1	3	0.36	0.86
Salivary flow before HD	0.1	1.7	0.51	0.35	0.1	1	0.37	0.25	0.1	1.8	0.35	0.26	0.1	1.8	0.39	0.28
Salivary flow after HD	0.3	2	0.77	0.41	0.1	1.3	0.61	0.32	0.1	1.8	0.52	0.29	0.1	2	0.61	0.34
Salivary flow difference	-0.2	0.7	0.27	0.21	0	0.5	0.24	0.14	-0.2	0.6	0.17	0.16	-0.2	0.7	0.21	0.17

Table 4. Analysis of the mean salivary flow and saliva pH before and after the HD session.

Variables	Mean	Standard deviation (SD)	Difference (before and after HD)	N (%) Before HD	N (%) After HD	p
pH before HD	7.18	0.87	0.36	-	-	<0.001 <sup>a</sup>
pH after HD	6.82	0.77		-	-	
Salivary flow before HD (ml/min)	0.39	0.28	0.21	-	-	<0.001 <sup>a</sup>
Salivary flow after HD (ml/min)	0.60	0.34		-	-	
Salivary flow						
≥1ml/min	-	-	-	5(3.9%)	17(13.3%)	<0.001 <sup>b</sup>
0.7-0.9ml/min	-	-	-	10(7.8%)	30(23.4%)	
0.4-0.6ml/min	-	-	-	53(41.4%)	55(43.0%)	
≤0.3ml/min	-	-	-	60(46.9%)	26(20.3%)	

<sup>a</sup> Paired t-test <sup>b</sup> Chi-Squared test

Table 5. Correlation between stimulated salivary flow before and after HD session and the study variables.

Variables	Salivaryflow beforeHD		Salivaryflow afterHD	
	Pearson'scorrelatio n	p	Pearson'scorrelat ion	p
Age	-0.188	0.033	-0.261	0.003
CPI	0.115	0.288	0.043	0.690
DMFT	-0.228	0.010	-0.304	0.001
pH beforeHD	0.182	0.040	0.231	0.009
pH afterHD	0.106	0.234	0.217	0.014
MonthsonHD	0.125	0.159	0.028	0.755