Influence of Frequent Nocturnal Home Hemodialysis on Food Preference

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Abstract

Objectives: Dialysis patients frequently report a change of taste that is reversible after renal transplantation, suggesting that uremic toxins may negatively influence taste. Currently, frequent nocturnal home hemodialysis (NHHD) is the most effective method of hemodialysis, and is associated with the lowest levels of uremic toxins. We studied preference for various foods as an indicator of taste perception. We questioned whether food preference differs between NHHD patients and those on conventional hemodialysis.

Design and patients: In this transverse, cross-sectional pilot study, we assessed food preference by means of a questionnaire for patients on NHHD (n=6; 8 hours of dialysis per night, for 5 or 6 nights a week) and 3 age-matched and sex-matched control groups: chronic home hemodialysis patients (HHD; n=9; 4 to 5 hours of dialysis per day, 3 days a week), chronic in-center hemodialysis patients (CHD; n=18; 4 to 5 hours of dialysis per day, 3 days a week), and healthy control subjects (HC; n=23).

Results: Mean scores for food preference did not differ between the groups (P=0.32). Similarly, the preference for product groups did not differ between groups. On an individual product level, we found only minor differences. The NHHD patients had a preference for savory snacks, as did the HC and the CHD groups, whereas the HHD group had a preference for sweet snacks (P<0.05). Hemodialysis patients reported dry mouth more often than did the HC (P<0.05).

Conclusion: Frequent NHHD has no major impact on food preference. The change in taste reported by NHHD patients is not related to their particular food preferences.
Introduction

Malnutrition in hemodialysis patients is associated with a higher morbidity and mortality rate. The cause of malnutrition is multifactorial. Contributing factors are higher energy needs, chronic fatigue, the dialysis process itself, and reduced food intake. Reduced food intake can have many causes, such as fewer eating moments on dialysis days because of the dialysis time and possible sickness during or after treatment, fatigue and nausea as a result of the hemodialysis itself, dietary restrictions, xerostomia, and reduced taste perception. Hemodialysis patients frequently report a change in taste. Based on clinical impression, this change in taste is reversible, because taste usually normalizes after renal transplantation. This finding suggests that uremic toxins accumulate as a result of renal failure, and negatively influence taste perception.

Frequent nocturnal home hemodialysis (NHHD) is currently the most effective method of hemodialysis and is associated with low blood levels of uremic toxins. The majority of patients gain weight, have higher protein intake, and report an increase in appetite after the transition from conventional hemodialysis to NHHD. This could be due to several factors, e.g., less postdialysis fatigue and nausea, more time to eat during the day, fewer dietary restrictions, and improved physical condition. At present it is unclear whether an improvement in taste perception may play a role.

Previous studies on taste perception focused predominantly on taste thresholds. Thresholds for sweet and sour stimuli were mostly increased, which led to the conclusion that dialysis patients are less sensitive to sweet and sour tastes. Interestingly, Burge et al. showed that thresholds may even differ before and after a dialysis treatment. Shepherd et al. also tested taste before and after hemodialysis, and observed a decreased preference for salt after dialysis sessions. Measuring thresholds can be useful for detecting changes in taste, but the threshold level is not necessarily related to a preference for certain food products. For instance, a patient may have an increased taste threshold for sweet, but may still have a preference for sweet foods.

An alternative approach to studying taste perception is to measure the preference for food products directly. This has its advantages: the preference for food products is relatively easy to measure, and is less time consuming for the patient. In addition, a preference for food products may be a better indicator of the actual food intake than are taste thresholds. Dobell et al. developed a food-preference questionnaire, and observed that sweet products, vegetable products, red meat, fish, and chicken-products are considered less preferable by hemodialysis patients, compared with control subjects. Product appreciations were used as indicator-variables. Here, we followed the concept of Dobell et al. We questioned whether food preference differs between patients on NHHD and those on conventional hemodialysis, as well as healthy control subjects. We addressed this question in a pilot study with a cross-sectional study design.
Pastents and Methods

Patients
The study population consisted of four groups: (1), a group of NHHD patients (n=6) (8 hours of dialysis per night, for 5 or 6 nights a week); (2), an internal control group of chronic home hemodialysis patients (HHD) (n=9) on a conventional hemodialysis scheme (4 to 5 hours of dialysis per day, 3 days a week); (3), an internal control group of chronic in-centre hemodialysis patients (CHD) (n=18) on a conventional hemodialysis scheme (4 to 5 hours of dialysis per day, 3 days a week); (4), an external group of healthy controls (HC) (n=23). Subjects in the CHD group were matched with the NHHD group for gender, age, and dialysis vintage. The HC group was matched with the NHHD group for gender and age. The HHD group could not be fully matched because of its relatively small size. All dialysis patients were treated by the same group of nephrologists and dieticians.

Exclusion criteria used for all groups were: short life expectancy (less than 6 months), absence of informed consent, acute intercurrent illness, and the use of any medications known to influence taste\(^13\).

The selected patients were asked to participate in the study by letter, with oral clarification by the investigators. Written informed consent was obtained from all participating patients. Ten NHHD patients were asked to participate, but 2 patients were transplanted before the start of the study, and one patient refused to participate. Of the remaining 7 patients, one was excluded because he used a medication that influenced taste.

Therefore, the final NHHD study group consisted of 6 patients. Sixteen HHD patients were asked to participate. Six of these patients refused to participate, and one used a taste-influencing medication. The final HHD group consisted of 9 patients. Twenty-three CHD patients were asked to participate. Four patients refused to participate, or were unable to participate because of language barriers. Of the remaining patients, one was excluded because of the use of a taste-influencing medication. The CHD group, therefore, contained 18 patients. Twenty-four HC were asked and, all agreed to participate in the study. One HC was excluded because of the use of a taste-influencing medication. The HC study group consisted of 23 subjects.

The study was performed in accordance with the principals of the Declaration of Helsinki and Guidelines for Good Practice.

Questionnaire
A food-preference questionnaire was developed. This questionnaire was based on the questionnaire of the Australian study by Dobell et al\(^12\). Commonly used Dutch food products were used for the questionnaire. In the initial phase of the questionnaire, a study of test-retest reliability was performed on 20 hemodialysis
patients. Only products with an intraclass correlation coefficient greater than 0.7 were included in the final version of the questionnaire.

The questionnaire consists of three parts: (1), demographic data, medication use, comorbidity, and medical history; (2), preference for food products, i.e., subjects were asked to rank 62 products on a 7-point scale, ranging from “dislike extremely” (1) to “like extremely” (7) (an example is given in Fig. 1); and (3), general questions related to taste and smell, such as preference for a hot meal versus a bread meal, savory versus sweet snacks, and complaints of dry mouth.

All participants were asked to fill out the questionnaire once. In order to standardize the interval between previous dialysis and the questionnaire, as well as the time of the day at which the questionnaire was filled out, we instructed patients as follows: NHHD patients were asked to fill out questionnaires on the morning after a nondialysis night; HHD and CHD patients were asked to fill out questionnaires on the morning of a nondialysis day; the HC group was asked to fill out the questionnaires in the morning.

For all patients, equilibrated Kt/V (eKt/V) and normalized Protein Catabolic Rate (nPCR, normalized grams of protein/kg/day) were measured within 3 months before or after the questionnaire.

Figure 1. *Hedonic scale for food preference, modified from Dobell et al.¹²*

<table>
<thead>
<tr>
<th>How do you like?</th>
<th>Dislike extremely</th>
<th>Dislike much</th>
<th>Dislike slightly</th>
<th>Neutral</th>
<th>Like slightly</th>
<th>Like much</th>
<th>Like extremely</th>
<th>Never tried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Peanut Butter</td>
<td>□</td>
<td>□</td>
<td>X</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Ice cream</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

**Statistical analysis**

First, comparisons between the research groups were made on a food-product level, e.g., a comparison of the preference for carrots between study groups. In a second analysis, food products were classified into different flavor groups (sweet, sour, salty, and bitter) and food-product groups (meat, poultry, fish, vegetables, fruit, and dairy). In this analysis, the overall preference for flavor groups and food-product groups was compared between study groups.

Data were analyzed using Statistical Package for the Social Sciences, version 12.0 (SPSS, Inc., Chicago, IL). Associations between nominal variables were tested using the $\chi^2$ test. The Mann-Whitney test was used to assess differences in food
preference between two groups. The Kruskal-Wallis test was used for multiple comparisons between groups. The Spearman rank-correlation coefficient was used to study the associations between different parameters. P<0.05 was considered significant.

**Results**

Table 1 summarizes the demographic and clinical characteristics of the four groups. No differences were found between the groups for all variables except Kt/V and nPCR, which were higher in the NHHD group compared with the HHD and CHD groups (P<0.05).

**Table 1: Demographic and clinical characteristics of the subjects**

<table>
<thead>
<tr>
<th></th>
<th>NHHD (n = 6)</th>
<th>HHD (n = 9)</th>
<th>CHD (n = 18)</th>
<th>HC (n = 23)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (%)</td>
<td>33</td>
<td>44</td>
<td>28</td>
<td>26</td>
<td>0.77</td>
</tr>
<tr>
<td>Age (y)</td>
<td>60±9</td>
<td>61±14</td>
<td>60±8</td>
<td>57±7</td>
<td>0.70</td>
</tr>
<tr>
<td>Dialysis vintage (y)</td>
<td>5±4</td>
<td>5±3</td>
<td>5±3</td>
<td>-</td>
<td>0.97</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>0</td>
<td>44</td>
<td>22</td>
<td>35</td>
<td>0.23</td>
</tr>
<tr>
<td>Dental prosthesis (%)</td>
<td>17</td>
<td>67</td>
<td>44</td>
<td>26</td>
<td>0.11</td>
</tr>
<tr>
<td>Previous Radiation in head/neck region (%)</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0.15</td>
</tr>
<tr>
<td>Previous CAPD/CCPD (%)</td>
<td>50</td>
<td>11</td>
<td>50</td>
<td>-</td>
<td>0.13</td>
</tr>
<tr>
<td>Previous renal transplantation (%)</td>
<td>17</td>
<td>22</td>
<td>11</td>
<td>-</td>
<td>0.75</td>
</tr>
<tr>
<td>Kt/V (weekly)</td>
<td>7.5±2.0</td>
<td>4.1±0.3</td>
<td>4.1±0.7</td>
<td>-</td>
<td>0.00</td>
</tr>
<tr>
<td>nPCR (gr. protein/kg/d)</td>
<td>1.3±0.2</td>
<td>0.9±0.2</td>
<td>1.0±0.2</td>
<td>-</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Data represent mean±SD, unless stated otherwise.

NHHD: nocturnal home hemodialysis; HHD: home hemodialysis; CHD: in-center hemodialysis; HC: healthy controls; CAPD/CCPD: continuous ambulant peritoneal dialysis/continuous cyclic peritoneal dialysis; nPCR: normalized Protein Catabolic Rate.
Table 2: Differences in food preference scores

<table>
<thead>
<tr>
<th></th>
<th>NHHD (n=6)</th>
<th>HHD (n=9)</th>
<th>CHD (n=18)</th>
<th>HC (n=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken filet</td>
<td>4.8±0.5</td>
<td>5.9±0.9</td>
<td>5.4±1.3</td>
<td>5.6±1.1</td>
</tr>
<tr>
<td>Mature cheese</td>
<td>4.5±0.8</td>
<td>5.4±1.7</td>
<td>5.9±0.8</td>
<td>5.4±1.7</td>
</tr>
<tr>
<td>Jam</td>
<td>4.7±1.0</td>
<td>5.3±1.1</td>
<td>5.6±0.9</td>
<td>5.4±1.0</td>
</tr>
<tr>
<td>Crisp bake</td>
<td>4.5±0.8</td>
<td>5.2±1.0</td>
<td>5.6±1.2</td>
<td>5.2±1.1</td>
</tr>
<tr>
<td>Beer</td>
<td>3.0±1.6</td>
<td>4.8±2.9</td>
<td>3.9±2.0</td>
<td>5.1±2.0</td>
</tr>
<tr>
<td>Pear</td>
<td>5.3±0.8</td>
<td>5.9±1.1</td>
<td>5.8±1.0</td>
<td>6.0±0.6</td>
</tr>
<tr>
<td>Breaded schnitzel</td>
<td>5.2±1.0</td>
<td>5.2±1.7</td>
<td>5.4±1.5</td>
<td>5.9±1.3</td>
</tr>
<tr>
<td>Red wine</td>
<td>2.8±1.2</td>
<td>3.8±1.9</td>
<td>4.1±2.3</td>
<td>5.0±1.8</td>
</tr>
<tr>
<td>Bouillon</td>
<td>5.5±1.4</td>
<td>4.6±1.2</td>
<td>5.6±0.9</td>
<td>5.3±1.1</td>
</tr>
<tr>
<td>Salted peanuts</td>
<td>4.5±1.8</td>
<td>3.7±1.1</td>
<td>5.0±1.5</td>
<td>5.5±1.0</td>
</tr>
<tr>
<td>Gherkin</td>
<td>5.0±1.3</td>
<td>5.0±1.0</td>
<td>5.7±0.8</td>
<td>5.2±1.0</td>
</tr>
<tr>
<td>Whipped cream</td>
<td>5.5±1.2</td>
<td>5.3±1.1</td>
<td>6.2±0.8</td>
<td>5.6±1.1</td>
</tr>
<tr>
<td>Milk</td>
<td>5.6±1.5</td>
<td>6.1±1.3</td>
<td>5.3±2.0</td>
<td>5.3±1.4</td>
</tr>
<tr>
<td>Black coffee</td>
<td>3.2±1.5</td>
<td>4.0±2.3</td>
<td>2.8±2.0</td>
<td>4.2±1.9</td>
</tr>
<tr>
<td>Tomato</td>
<td>5.3±2.3</td>
<td>5.8±1.2</td>
<td>4.6±1.1</td>
<td>5.9±0.9</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>4.5±1.4</td>
<td>4.3±2.0</td>
<td>3.4±2.0</td>
<td>4.9±1.7</td>
</tr>
</tbody>
</table>

Data represent mean±SD.

NHHD: nocturnal home hemodialysis; HHD: home hemodialysis; CHD: in-center hemodialysis; HC: healthy control subjects.

1-6 P<0.05 significant: 1NHHD vs. HHD, 2NHHD vs. CHD, 3NHHD vs. HC, 4HHD vs. CHD, 5HHD vs. HC, 6CHD vs. HC.

Mean (±SD) scores for food preference did not differ significantly (P=0.32) between patients on NHHD (5.0±1.3), patients on HHD (5.2±1.5), patients on CHD (5.0±1.6), and HC (5.3±1.3). We found no difference in preference for either flavor group or food-product group between NHHD and the 3 control groups. On the food-product level, we found only minor differences, as shown in Table 2. Differences were evident between NHHD and HHD patients for chicken fillet and mature cheese (P<0.05), between NHHD and CHD for jam, crisp bake and mature cheese (P<0.05), and between NHHD patients and the HCs for beer, pear, chicken fillet, mature cheese, breaded schnitzel and red wine (P<0.05).

As shown in Table 3, 60% of the NHHD patients preferred savory snacks, which was comparable with the CHD patients (56%) and the HCs (83%). Remarkably, only 11% of HHD patients preferred savory snacks (P<0.05). No differences between groups were found for the preference of either a hot meal or a bread meal.
Table 3: Preference for type of snacks

<table>
<thead>
<tr>
<th></th>
<th>NHHD (n = 6)</th>
<th>HHD (n = 9)</th>
<th>CHD (n = 18)</th>
<th>Control subjects (n = 23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savory snacks (%)</td>
<td>60</td>
<td>11</td>
<td>56</td>
<td>83</td>
</tr>
<tr>
<td>Sweet snacks (%)</td>
<td>0</td>
<td>44</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>No preference (%)</td>
<td>40</td>
<td>44</td>
<td>33</td>
<td>17</td>
</tr>
</tbody>
</table>

Difference between groups, P<0.05.

NHHD: nocturnal home hemodialysis; HHD: home hemodialysis; CHD: in-center hemodialysis.

As shown in Figure 2, we found a significant difference between groups for complaints of dry mouth ($\chi^2=27.94; P<0.05$). These complaints were more frequent in the 3 dialysis groups, compared with the HC group.

We found a negative correlation between the preference for the food-product group poultry (combination of chicken schnitzel, chicken fillet, and turkey fillet) and the eKt/V of all hemodialysis groups ($r=-0.5, P=0.007$). On the product level, there were negative correlations between the eKt/V of all hemodialysis groups and the preference for a few individual food items: mashed apples ($r=-0.4, P=0.031$), chicken schnitzel ($r=-0.6, P=0.027$), chicken fillet ($r=-0.6, P=0.001$), and tartar ($r=-0.4, P=0.029$).

Figure 2. Percentages of patients with complaints of dry mouth

NHHD: nocturnal home hemodialysis; HHD: home hemodialysis; CHD: in-center hemodialysis; HC: healthy control subjects.
On the food product level, negative correlations with dialysis vintage of all hemodialysis groups were found for a few products: chicken fillet ($r=-0.4$, $P=0.034$), breaded schnitzel ($r=-0.4$, $P=0.028$), piece of ham ($r=-0.04$, $P=0.022$), and turkey fillet ($r=-0.4$, $P=0.051$). The preference for the product group fruit correlated negatively with age within all research groups ($r=-0.3$, $P=0.033$).

In hemodialysis patients, negative correlations were found between age and the preference for a few products: brown bread ($r=-0.4$, $P=0.044$), fried pieces of breaded whitefish ($r=-0.5$, $P=0.004$), and cola ($r=-0.5$, $P=0.004$).

### Discussion

We found no consistent difference in food preference between patients on frequent NHHD and those on conventional hemodialysis or home hemodialysis. Thus, the method of hemodialysis does not seem to have a consistent impact on food preference.

We observed no differences in the preference for food-product groups and flavor groups between the NHHD and control groups. Only minor differences were evident for individual products. These minimal differences for single products are probably coincidental. We had hypothesized that NHHD patients would score higher on the hedonic food preference scale, but we found the opposite: NHHD patients scored lower than the CHD and HHD patients. Thus, it seems plausible that other factors than a change in taste perception may increase food intake.

The NHHD group most often experienced dry mouth. The probable cause for this finding involves the hydration state of these patients. During frequent nocturnal hemodialysis, fluid is more easily extracted from the body because of the high number of hours on dialysis per week. Therefore, NHHD patients, on average, likely have a lower hydration status than do HHD and CHD patients. It is well-known that xerostomia has a negative influence on taste\textsuperscript{14,15}. Therefore, the finding that NHHD patients more often experienced dry mouth may have influenced food preference scores in these patients.

The HHD group differed from the other two dialysis groups and from the HC group with respect to a lower preference for savory snacks and a higher preference for sweet snacks. At present, we do not have an explanation for this observation.

Dobell et al.\textsuperscript{12} found that red meats, fish and poultry, and eggs are less pleasant for hemodialysis patients ($n=33$) than for continuous ambulant peritoneal dialysis (CAPD) patients ($n=17$). A bigger difference seems to exist in food preference between patients receiving CAPD and patients on hemodialysis than between patients on different methods of hemodialysis. Dobell et al.\textsuperscript{12} also found a difference between hemodialysis patients and the “healthy” control group ($n=30$) with respect to sweet foods, vegetables, red meats, and fish and poultry. We could not confirm this finding. Remarkably, we found a negative correlation between eKt/V
and the preference for certain products (in particular poultry products). We have no explanation for this finding.

Within the hemodialysis groups, we found a negative correlation with age for three products. Age has an important influence on taste perception. De Graaf et al. reported considerable differences between young and elderly subjects regarding the sensory perception and pleasantness of food flavours. Elderly persons seem to prefer higher concentrations of food flavors, but the optimal concentration of these components in food products for this group is unclear.

Our results should be considered preliminary. This study has several limitations. First, the study groups are relatively small. Unfortunately, the complete lack of data on food preference in NHHD patients precluded a prestudy power analysis. Therefore, this study is a pilot study. However, a post-hoc power analysis demonstrated a power of 65% in this study to detect a 1.5-point difference and a power of 88% to detect a 2-point difference on the 7-point hedonic food-preference scale between CHD (n=18, SD=1.575) and NHHD (n=6, SD=1.28) patients. Second, taste preference was measured only once in each patient. Taste preferences may differ during the day, and may change over time because of intercurrent diseases. However, we sought to limit such effects by standardizing the moment at which the questionnaire was filled out, and by excluding patients with intercurrent illnesses. In addition, the NHHD group was well matched with the CHD and HC groups.

Olfactory function is also important in relation to taste. We did not include tests for olfactory function in this study. A decrease in odor perception was evident in elderly persons with poor health, and in malnourished people. Several studies of odor perception in dialysis patients used smell-detection thresholds. Van Griep et al. showed that odor perception correlated positively with creatinine clearance. A negative correlation was found between odor perception and serum concentration of urea, serum phosphorus, and protein catabolic rate. Frasnelli et al. also observed impaired recognition of odors in patients with chronic renal failure as compared with healthy people.

Taste preference is difficult to define. It indicates an appreciation for something, and the decision to choose something. “Taste preference” suggests that, in general, one probably eats more of something that one finds tasty, although one may well realize that it is better not to eat too much of it. The CHD group scored the products higher on the hedonic scale, but this does not necessarily imply that they will eat more of it because of adherence to dietary restrictions and/or impaired appetite. Appetite is not the same as food preference. Many factors may influence the taste of hemodialysis patients, such as xerostomia or deficiencies of certain vitamins and trace elements. Other side effects of dialysis, such as dry mouth, thirst, impaired sweet and salty taste, and abnormal sensitivity, can also affect taste. Uremia is known to be associated with poor appetite and malaise. The loss of hunger sensation and appetite and the development of anorexia during dialysis can be explained by numerous causes, such as inadequate dialysis, unpalatable or inadequate diets, medications, psychosocial and socioeconomic
factors, acidosis, depression, and low physical activity. Most of these factors are
difficult to alleviate3,23. The NHHD patient has fewer dietary restrictions and uses
fewer medications, such as phosphate and potassium binders, that can affect
appetite.

In conclusion, the method of hemodialysis does not seem to have a consistent
impact on food preference. The change in taste reported by NHHD patients is not
related to preference for foods.
References
