Impaired Taste and Increased Mortality in Acutely Hospitalized Older People

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Abstract

Taste ability is known to be impaired in elderly and even more so in acutely hospitalized elderly people. To our knowledge, no study has investigated the association between taste impairment and mortality. Our aim was to examine this association in acutely hospitalized older people. In a prospective study, 200 acutely hospitalized elderly people ≥70 years of age were included between November 2009 and October 2010 at the Oslo University Hospital, Norway. Exclusion criteria were cognitive impairment, nursing home residency, and terminal diseases. Comorbidity was registered with the Cumulative Illness Rating Scale, in addition to recording of age, gender, smoking, education, and number of medications. Taste ability was assessed quantitatively with the "taste strips method" in 174 patients (mean age: 84 years). Mortality until 1 January 2012 was obtained from hospital records. Fifty-six patients died during the observation period. The relative risk of death in total taste score quartile 4 compared with total taste score quartile 1 was 0.31 (95% confidence interval [95% CI]: 0.14–0.69, \(P = 0.004\)), after adjusting for age, gender, smoking, education, and Cumulative Illness Rating Scale. Adjusted 1-year mortality decreased from 30% in total taste score quartile 1 to 9% in total taste score quartile 4. Thus, impaired taste appears to be strongly associated with mortality in acutely hospitalized elderly people.

Key words: elderly, survival, taste ability, taste strips

Introduction

Mortality in older people is associated with a variety of diseases and disease-related factors, such as cardiovascular diseases (Bouzas-Mosquera et al. 2012), chronic obstructive lung disease (Terzano et al. 2010), hip fractures (Richmond et al. 2003; Abrahamsen et al. 2009), undernutrition (Payette et al. 1999), oral health (Osterberg et al. 2008; Marin-Zuluaga et al. 2012), and smoking (LaCroix and Ommen 1992; Holahan et al. 2013), in addition to age and gender. Acutely hospitalized older people comprise frail and weak individuals often burdened with such diseases (Rubinsztajn and Chazan 2011), who use several medications (Leikola et al. 2012) and frequently suffer from undernutrition (Mowe and Bohmer 1996; Ranhoff et al. 2005). Sensory functions weaken with increasing age. Vision and hearing, as well as olfaction (Schiffman 1997), exhibit deteriorating changes. Interestingly, problems with odor identification have also been linked to increased mortality in older adults (Wilson et al. 2011; Gopinath et al. 2012). Furthermore, taste perception is shown to be impaired in elderly people, (Schiffman and Gatlin 1993; Kameda et al. 2000), and even more so in acutely hospitalized elderly people (Solemdal et al. 2012a). These older patients often complain about reduced taste ability and poor appetite. There is reason to believe that these factors may have a negative influence on their nutritional status (Mowe and Bohmer 2002), with consequences for their general health. Furthermore, taste impairment has been associated with many of the aforementioned conditions related to mortality, such as age (Murphy and Gilmore 1989; Nordin et al. 2003), gender (Hyde and...

Due to the fact that there may be a relation between taste, appetite, and nutrition and because poor nutritional status in older people has an impact on diseases as well as life expectancy, we raised the question whether impaired taste was associated with increased mortality. To our knowledge, no such study has been performed. The aim of the present study was to examine such a possible association.

Materials and methods

In this prospective study, hospitalized elderly people were consecutively included between November 2009 and October 2010 at the Oslo University Hospital, Norway. The inclusion criteria were acutely hospitalized individuals aged at least 70 years, living in their own homes prior to hospital admission. Exclusion criteria were cognitive impairment, nursing home residency, and terminal diseases. The patients were evaluated for participation 48 h after hospital admission by 2 experienced physicians in geriatric medicine. Evaluation of cognitive function was based on thorough interviews with the patients by the head physician. Among the questions to be answered correctly were those related to date of birth, home address, and present day, month, and year. Overall, 234 patients met the inclusion criteria and were asked to participate, 200 of whom accepted. Reported reasons for non-acceptance included the following: “feeling too sick,” “too tired,” “not interested,” “having visitors,” or “going home soon.” The participants gave written informed consent. The study was approved by the Norwegian Committee for Medical Research Ethics.

Mortality until 1 January 2012 was obtained from hospital records. The examinations and data collection were conducted at the hospital bedside. Information about prescribed medications was obtained from the medical records at baseline. A predefined questionnaire was used to collect information such as education level and smoking status.

Comorbidity assessment

Comorbidity was assessed with the Cumulative Illness Rating Scale (CIRS; Miller et al. 1992; Salvi et al. 2008) by a physician in geriatric medicine. This index describes medical burden and comorbidity in older people. The CIRS comprises 14 different organ systems, rating severity of illness from 0 to 4. The different levels are as follows: 0 = no problem affecting that system or past problem without clinical relevance, 1 = current mild problem or past significant problem, 2 = moderate disability or morbidity and/or requires first-line therapy, 3 = severe/or constant and significant disability and/or hard-to-control chronic problems (complex therapeutic regimen), and 4 = extremely severe problem and/or immediate treatment required and/or organ failure and/or severe functional impairment. The scores are summarized, and the highest possible score is 56.

Taste assessments

Whole mouth taste assessment was carried out with the “taste strips method” (Mueller et al. 2003; Landis et al. 2009). The taste strips are prefabricated and impregnated with sweet, sour, salty, and bitter taste solutions in 4 different concentrations each. The concentrations are as follows: sweet taste: 0.05, 0.1, 0.2, and 0.4 g/ml sucrose; sour taste: 0.05, 0.09, 0.165, and 0.3 g/ml citric acid; salty taste: 0.016, 0.04, 0.1, and 0.25 g/ml NaCl; and bitter taste: 0.0004, 0.0009, 0.0024, and 0.006 g/ml quinine–HCl. The strips were given to the participants according to a predefined procedure. Patients and examiner were blinded as to the order, quality, and concentrations given. The individual taste strip was placed in the middle of the anterior region of the tongue. The patient was allowed to suck on the strip for maximum 20 s. A poster with the words “sweet,” “sour,” “salty,” and “bitter” was placed in front of the patient who had to decide on one of the taste qualities without delay. Before starting, and in between every taste strip, the patient was asked to rinse with water to cleanse the mouth. The patient had to confirm that the former taste had disappeared before the next taste strip was placed on the tongue. Correct identification was given score 1 and incorrect identification was given score 0. The correct scores were summarized, and the maximum total taste score (TTS) was 16. Medical and laboratory procedures, having visitors, and busy with eating resulted in 26 dropouts. Thus, taste assessments were obtained in 174 patients (119 women and 55 men). These patients participated in the mortality study.

Statistics

The statistical package IBM Statistics (version 19) was used for statistical analysis. Chi-square test was used to test associations between binary variables. When comparing continuous variables in 2 groups, a 2-sided independent samples t-test was used as long as the distributions of the variables were sufficiently close to normal distribution. If not, a 2-sided Mann–Whitney test was used. TTS was divided into quartiles for statistical analysis. ANOVA was used to calculate P values when comparing the taste qualities in Table 2 on the continuous variables age, number of medications, and CIRS. When comparing the other variables in Table 2, a chi-square test was used. The association between TTS and mortality was assessed with proportional hazards models (Cox). The final model included the covariates age, gender, smoking, education level, and CIRS sum, as well as quartiles of TTS. Cumulative survival curves for TTS quartiles were estimated by Kaplan–Meier plots to investigate the association.
between TTS and mortality. In order to adjust this association for confounders, Cox regression analysis was used. The significance level was set to 5%.

Quality assurance of data transfer from paper records to computer files was assessed by monitoring every 10th record.

Results

Table 1 shows that the mean TTS was 8.7 ± 2.6, mean age was 83.5 ± 6.1 years (70–103 years), 68% were women, 12% were current smokers, and 76% had less than 12 years of education. The mean number of medications used daily was 6.9 ± 3.2, and mean CIRS was 14.8 ± 5.2. Fifty-six patients died during the observation period (Table 1). The patients who died had significantly lower TTS compared with patients who survived (P = 0.003). Furthermore, the patients who died were significantly older (P < 0.001) and had significantly higher CIRS sum (P = 0.009). Gender, smoking, education level, and number of medications were not significantly associated with mortality.

Men had significantly lower mean TTS compared with women (7.6 ± 2.5 vs. 9.2 ± 2.6, P < 0.001). Figure 1 illustrates, separately for men and women, the distribution of mean TTS after dividing the patients in 2 age groups (aged 70–84 years and 85–103 years, respectively). Mean TTS for men was similar in the 2 age groups. Women in the oldest age group had slightly lower mean TTS, but the difference was not significant.

Dropouts from taste testing (26 patients) were analyzed according to age, gender, smoking status, education level, and the comorbidity index CIRS. Only smoking was significantly increased among the dropouts compared with the same among nondropouts (26.9% vs. 11.5%, P = 0.032).

Table 2 shows that the percentage of women was significantly lower in TTS quartile 1 compared with that in TTS quartile 4. The CIRS sum was significantly higher in TTS quartile 1 compared with that in TTS quartile 4 (P = 0.025). There was no significant difference between the TTS quartiles with regard to age, smoking, education level, and number of medications.

Tables 3–5 show the change in the relative risk of death for TTS quartile 2, TTS quartile 3, and TTS quartile 4 vs. TTS quartile 1 after adjusting for various confounders. The relative risk of death in TTS quartile 4 compared with that in TTS quartile 1 was 0.30 (P = 0.002) after adjusting for age and gender (Table 3). Only a minor change was noted when CIRS was added to the model (relative risk = 0.32, P = 0.004; Table 4). In the final model (Table 5), the relative risk of death in TTS quartile 4 compared with that in TTS quartile 1 was 0.31 (95% CI: 0.14–0.69, P = 0.004) after adjusting for all confounders (age, gender, CIRS, smoking status, and education level). The risk of death was 58%, 48%, and 69% lower, respectively, when comparing TTS quartiles 2, 3, and 4 with TTS quartile 1 (Table 5).

Table 1 Characteristics of participants in mean (SD) and percentages, according to mortality

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total N = 174 patients</th>
<th>Dead, n = 56</th>
<th>Alive, n = 118</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total taste score, mean (SD)</td>
<td>8.7 (2.6)</td>
<td>7.8 (2.9)</td>
<td>9.1 (2.5)</td>
<td>0.003</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>83.5 (6.1)</td>
<td>86.0 (5.5)</td>
<td>82.4 (5.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Men, %</td>
<td>32</td>
<td>42</td>
<td>58</td>
<td>0.06</td>
</tr>
<tr>
<td>Women, %</td>
<td>68</td>
<td>28</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Smoking, %</td>
<td>12</td>
<td>40</td>
<td>60</td>
<td>0.45</td>
</tr>
<tr>
<td>No smoking, %</td>
<td>88</td>
<td>31</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Education level ≥ 12 years, %</td>
<td>24</td>
<td>24</td>
<td>76</td>
<td>0.22</td>
</tr>
<tr>
<td>Education level &lt; 12 years, %</td>
<td>76</td>
<td>35</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Medications, mean (SD)</td>
<td>6.9 (3.2)</td>
<td>7.4 (3.1)</td>
<td>6.7 (3.3)</td>
<td>0.22</td>
</tr>
<tr>
<td>CIRS sum, mean (SD)</td>
<td>14.8 (5.2)</td>
<td>16.3 (5.6)</td>
<td>14.1 (4.9)</td>
<td>0.009</td>
</tr>
</tbody>
</table>

Abbreviation: SD, standard deviation.
Figure 2 presents the adjusted survival curves for each TTS quartile. Adjusted 1-year mortality decreased from 30% in TTS quartile 1 to 9% in TTS quartile 4.

Discussion

In this study of acutely hospitalized older people, we have shown that impaired taste was strongly and independently associated with mortality. Patients with the best taste scores had 69% lower risk of death during the observation period compared with patients with the most impaired taste scores, after adjusting for age, gender, smoking, education, and comorbidity.

The finding of markedly increased mortality in patients with the most impaired taste was surprising. However, clinical studies have shown that taste perception and appetite are reduced in frail and sick older people (Schiffman and Graham 2000; Solemdal et al. 2012a; Toffanello et al. 2013), leading in many cases to undernutrition and diseases with serious consequences for the patients (Mowe et al. 1994; Donini et al. 2003).

Ageing influences all organs in the body. Ageing has also been shown to be associated with reduced taste perception, and the individual taste qualities are impaired to various degrees (Murphy and Gilmore 1989; Stevens and Cain 1993; Nordin et al. 2003). There are many tentative explanations for this age-related decline in taste perception. Whether this is due to a reduction in taste bud numbers, taste receptors, impaired signal transduction, or other more central

Table 2 Distribution of selected variables according to TTS quartiles in 174 hospitalized older individuals, presented in mean (SD) and percentages

<table>
<thead>
<tr>
<th>TTS quartiles</th>
<th>Quartile 1</th>
<th>Quartile 2</th>
<th>Quartile 3</th>
<th>Quartile 4</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td>36</td>
<td>47</td>
<td>40</td>
<td>51</td>
<td>—</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>4.9 (1.4)</td>
<td>7.6 (0.5)</td>
<td>9.4 (0.5)</td>
<td>11.8 (1.1)</td>
<td>—</td>
</tr>
<tr>
<td>Age in years, mean (SD)</td>
<td>82.5 (6.9)</td>
<td>84.0 (5.7)</td>
<td>84.1 (6.8)</td>
<td>83.4 (5.2)</td>
<td>0.94</td>
</tr>
<tr>
<td>Women, %</td>
<td>42</td>
<td>66</td>
<td>75</td>
<td>84</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Smokers, %</td>
<td>14</td>
<td>6</td>
<td>15</td>
<td>12</td>
<td>0.92</td>
</tr>
<tr>
<td>Education level &lt; 12 years, %</td>
<td>72</td>
<td>79</td>
<td>75</td>
<td>78</td>
<td>0.85</td>
</tr>
<tr>
<td>Medications, mean (SD)</td>
<td>6.5 (3.3)</td>
<td>7.9 (3.5)</td>
<td>5.8 (2.9)</td>
<td>7.3 (3.0)</td>
<td>0.74</td>
</tr>
<tr>
<td>CIRS sum, mean (SD)</td>
<td>16.2 (6.3)</td>
<td>15.9 (4.7)</td>
<td>12.6 (4.3)</td>
<td>14.5 (4.9)</td>
<td>0.025</td>
</tr>
</tbody>
</table>

Abbreviation: SD, standard deviation.

Table 3 Associations between total taste score and mortality, adjusted for age and gender

<table>
<thead>
<tr>
<th>Variables</th>
<th>RR</th>
<th>95% CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total taste score*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2 versus Q1</td>
<td>0.39</td>
<td>0.20–0.80</td>
<td>0.009</td>
</tr>
<tr>
<td>Q3 versus Q1</td>
<td>0.43</td>
<td>0.21–0.91</td>
<td>0.027</td>
</tr>
<tr>
<td>Q4 versus Q1</td>
<td>0.30</td>
<td>0.14–0.65</td>
<td>0.002</td>
</tr>
<tr>
<td>Gender: women versus men</td>
<td>0.73</td>
<td>0.42–1.27</td>
<td>0.26</td>
</tr>
<tr>
<td>Age: 10-year increase</td>
<td>2.49</td>
<td>1.62–3.84</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Abbreviation: RR, relative risk.
*Total taste score was divided into quartiles.

Table 4 Associations between total taste score and mortality, adjusted for age, gender, and CIRS sum

<table>
<thead>
<tr>
<th>Variables</th>
<th>RR</th>
<th>95% CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total taste score*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2 versus Q1</td>
<td>0.42</td>
<td>0.21–0.86</td>
<td>0.017</td>
</tr>
<tr>
<td>Q3 versus Q1</td>
<td>0.52</td>
<td>0.24–1.12</td>
<td>0.097</td>
</tr>
<tr>
<td>Q4 versus Q1</td>
<td>0.31</td>
<td>0.14–0.69</td>
<td>0.004</td>
</tr>
<tr>
<td>Gender: women versus men</td>
<td>0.67</td>
<td>0.37–1.22</td>
<td>0.19</td>
</tr>
<tr>
<td>Age: 10-year increase</td>
<td>2.58</td>
<td>1.62–4.11</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Smoking: smokers versus nonsmokers</td>
<td>1.62</td>
<td>0.75–3.51</td>
<td>0.22</td>
</tr>
<tr>
<td>Education level*: low versus high</td>
<td>1.87</td>
<td>0.89–3.92</td>
<td>0.10</td>
</tr>
<tr>
<td>CIRS sum: 1-score increase</td>
<td>1.05</td>
<td>0.99–1.11</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Abbreviation: RR, relative risk. Results are from Cox regression analysis.
*Total taste score was divided into quartiles. *Education level comprises education level <12 years (low) and education level ≥ 12 years (high).
mechanisms is not yet clarified (Bradley et al. 1985; Bradley 1988; Miller 1988; Mavi and Ceyhan 1999). Even though age was the strongest predictor of mortality in our study, the association between taste ability and mortality remained significant after adjusting for age. Furthermore, it is known that diseases such as common cold, brain damage, chronic liver, and renal diseases (Schiffman 1997), as well as various medications (Doty et al. 2008), may impair taste perception. More than 250 medications have the ability to interfere with taste perception (Ackerman and Kasbekar 1997). Due to this knowledge, we registered the number of prescribed medications and assessed the disease burden with the CIRS index. In our study, we anticipated medications to be significantly associated with both taste ability and mortality, but this was not the case. Many of our participants had an intake of several medications daily. However, in some patients, many medications were related to the same disorder or disease (e.g., cardiovascular diseases). This may explain why there was significant association neither between medications and total taste score nor between medications and mortality. Furthermore, an Italian study (Salvi et al. 2008) has previously reported association between mortality and comorbidities, assessed with CIRS. As expected, CIRS was associated with mortality in our study. Notably, patients with the lowest taste scores also had the highest CIRS scores. Despite these findings, the association between impaired taste and increased mortality remained significant even after adjusting for CIRS.

Analysis showed that smoking occurred significantly more often among the 26 dropouts compared with our study population. Smoking may interfere with taste perception (Suliburska et al. 2004). However, because there was no significant association between taste score and smoking in our study population, we assume that the difference in smoking status between these groups had no influence on our results.

In view of the fact that impaired olfaction may interfere with taste perception (Kaneda et al. 2000; Landis et al. 2010), it is interesting to note that association between impaired olfactory function and increased mortality in elderly people (Wilson et al. 2011; Gopinath et al. 2012) has been reported. Impaired olfaction has been suggested to be a marker of underlying neurodegenerative changes, possibly explaining its association with mortality (Wilson et al. 2011). Moreover, idiopathic Parkinson’s disease in elderly people is associated with reduced olfactory function (Haehner et al. 2009) and to a lesser degree with impaired taste function (Kim et al. 2011). A relationship between diminished taste and cognitive decline has also been reported (Lang et al. 2006). In our study, patients with dementia and cognitive decline were excluded. However, 1 of the 14 CIRS categories comprises various neurological disorders. We therefore analyzed the relationship between that disease category and taste/mortality. However, no such association was found (data not shown).

Our study may be weakened by the lack of testing for smelling performance among the participants. Whether information about olfaction would have influenced our results is not known. The literature clearly shows that smell and taste functions are mediated through different mechanisms (receptors, signal molecules, and transmission through different nerves to specific sensory areas in the brain cortex; Schiffman and Gatlin 1993). However, many publications indicate that odor and flavor have a certain importance for taste function (e.g., Landis et al. 2010). Multimodal neurons in the orbitofrontal cortex acting on stimuli from smell and taste have been reported (Rolls 2012), but there is no concluding evidence that taste function is dependent on smell function. This is supported by the fact that many studies fail to show influence of olfaction on taste (Vennemann et al. 2008; Stinton et al. 2010). Complaints with regard to tasteless food have in many cases been due to impaired olfactory functions rather than impaired taste function (Deems et al. 1991; Spielman 1998). There are even indications that smell function could be suppressed by taste function (Fortis-Santiago et al. 2010). However, given that flavor and odor are important components when tasting food, we selected dry taste strips devoid of odor for taste testing. Therefore, there is reason to believe that olfaction function had a minor influence on the patients’ taste ability in our study.

**Conclusion**

Patients with the best taste scores (TTS quartile 4) had almost 70% better survival rate compared with patients with severely impaired taste (TTS quartile 1), after adjusting for confounders. Thus, impaired taste appears to be strongly associated with mortality in acutely hospitalized elderly
people, indicating that chemosensory perception degenerates when life approaches the end. To what extent this finding may reflect a peripheral or central blunting of taste recognition remains to be investigated.

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**References**


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