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Dental Caries in Older Adults in the Last Year of Life

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Abstract

BACKGROUND/OBJECTIVES—Older adults experience dramatic declines in health and function at the end of life. These complex physiological, psychological and functional changes may substantially increase risk of dental caries. This study's objective was to examine dental caries severity (measured by number of carious teeth) in older adults in the last year of life.

DESIGN—Cross-sectional study based on dental records

SETTING—A community-based geriatric dental clinic

PARTICIPANTS—1216 older adults aged 65 or above, including 168 individuals in the last year of life (e.g., individuals died within one year after their new patient exams).

MEASUREMENTS—Participants' socioeconomics, medical history, medications, functional status and oral health measures, including number of carious teeth, were abstracted from dental records. End-of-life status was determined using the National Death Index. Propensities of death were first calculated using a logistic regression, then adjusted together with mobility and oral care function in the multivariable regression model to examine the impact of end-of-life status on dental caries.

RESULTS—Caries severity differed in end-of-life participants with different oral care function. Among those needing help with oral care, end-of-life participants had only slightly elevated and non-statistically significant risk (7.5 vs. 6.1, adjusted IDR= 1.12, 95% CI=0.85–1.48) to have more carious teeth than those not in the last year of life. However, caries severity decreased among end-of-life participants without impaired oral care function (IDR=0.53, 95% CI: 0.30–0.92).

CONCLUSION—Oral care function modifies the association between caries severity and end-of-life status. Individuals who could maintain oral hygiene independently had a relatively low level of caries at the end of life; however, dental caries had increased before functionally-dependent patients entered their last year of life.

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The authors have no financial or any other kind of personal conflicts with this paper

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Study concept and design: XC. Data analysis: JC and JP. Interpretation of data and manuscript preparation: all authors.

Keywords

Dental caries; end of life; older adults

INTRODUCTION

Older adults experience dramatic physiological, psychological and functional changes at the end of life¹, which may substantially increase risk of dental caries. As death approaches, ability to perform activities of daily living (ADLs), including oral hygiene, may substantially decline. Consequently, oral hygiene is often poor in those reaching the end of life with functional impairment. Elevated disease burden and intensive treatment may also induce oral complications. Drug-related xerostomia is also highly prevalent in end of life patients^{2,3}. Cancer treatment can cause salivary dysfunction³ and painful oral mucositis and stomatitis^{2,4}, hindering proper oral hygiene. Poor oral hygiene and reduced salivary flow increase the risk of dental caries.

Dental caries is one of the major causes of dental pain and infection and may substantially compromise quality of life in older adults at the end of life. Dental pain can limit food choice and nutritional intake, which not only compromise quality of remaining life but could also accelerate terminal health and functional decline. Prolonged moderate-to-severe intensity pain, including dental pain, can cause disruptive behaviors in cognitively-impaired persons⁵ and disturb the homeostatic equilibrium among frail older adults, increasing the risk of cardiovascular complications^{6,7}. When pathogenic organisms enter the systemic circulation, dental infection may result in life-threatening septicemia in immunocompromised patients⁸.

Despite its impact on health and quality of life, the prevalence and severity of dental caries in older adults in the last year of life have not been investigated. This lack of information increases the challenge for dental professionals to appropriately manage dental caries and associated complications for older adults at the end of life. To address this issue, we conducted the present study to examine the association between being in the last year of life and dental caries severity (measured by the number of carious teeth).

MATERIALS AND METHODS

The present study was a cross-sectional study based on existing data. The University of North Carolina Institutional Review Board approved the research protocol.

Study participants

During the study, we reviewed 1627 dental records of patients who received treatment as new patients between 10/23/1999-12/31/2006 in a university-affiliated geriatric dental clinic in St. Paul, Minnesota. Among the 1627 patients, 1216 were 65 years and older and were included in this analysis as study participants. The study participants included community-dwelling older adults and long-term care (LTC) residents.

Assessment of study participants

The 1216 study participants received a comprehensive new patient exam when they first arrived to the study clinic. These assessments were completed by the dentists of the study clinic and included four components: 1) Review of medical history and medications. For LTC patients, their medical history and medications were directly transferred from their facility record. For community-dwelling patients, this information was provided by patients or reliable family members when patients were cognitively impaired or functionally

dependent and was collected using a structured questionnaire; 2) Oral assessment, including dentition status, oral hygiene, periodontal health, caries assessment and denture assessment (when appropriate). When necessary, full mouth radiographs were taken for the purpose of diagnosis and treatment planning; 3) Cognitive assessment, including memory, orientation and judgment. Based on a set of subjective approaches⁹, dentists assessed patients' cognition using a 4-level scale: normal, slight impairment, moderate impairment and severe impairment; 4) Functional assessment, including oral care capacity and mobility. Oral care function was assessed on a 3-level scale (e.g., self-sufficient, need supervision or help, and patient won't cooperate). Mobility was evaluated on a 4-level scale: walks independently, needs a walker/wheelchair but transfers independently, needs assistance in transfer and bedridden; 5) Other assessments, including level of cooperation to care and language impairment (e.g. whether patients were able to communicate their oral health needs during the exam). These clinical data, together with patients' sociodemographics, were abstracted from dental records for the analysis.

Data collection

Based on dental clinical chartings and radiographs, the outcome of interest, number of carious teeth (including retained roots), was abstracted from dental records. During data collection, we carefully reviewed patients' records and verified the caries lesions with their radiographs. Dental caries and retained roots were then grouped into one variable -- the number of carious teeth -- to measure dental caries severity. The following oral health measures were also abstracted: 1) number of teeth; 2) number of teeth with restorations; 3) oral hygiene and gingival inflammation and 4) use of a removable dental prosthesis.

The primary exposure was being in the last year of life. By linking the clinical database with the National Death Index (NDI), a national, computerized index of death record information, we identified 168 participants who died within one year after their new patient exam. These participants were considered being the last year of life (end-of-life group) at the time of the exam. The rest of 1048 participants consisted of the comparison group.

Other covariates including sociodemographics, comorbidity, medications, cognitive and functional impairment, level of cooperation, language impairment and oral health measures (Table 1) were also abstracted from dental records. Based on the medical history and medication data, we calculated the Charlson Comorbidity Index (CCI) score¹⁰ and the Anticholinergic Drug Scale (ADS) score^{11,12} to measure the burden of comorbidity and the drug-related anticholinergic burden. To minimize the potential variations resulting from subjective assessment, we created a new 3-level scale by combining the categories of moderate and severe impairment, to measure cognitive impairment in this analysis.

Data analysis

The goal of this analysis was to see whether being in the last year of life is associated with dental caries severity. To adjust for multiple factors (e.g., age, disease burden, cognitive impairment etc.) and their interactions that may confound this association, a propensity of death was calculated¹³ and carried into the multivariable analysis. The propensity of death is the probability of death in one year given age, gender, residential status, health insurance, the CCI score, number of medications, ADS score, cognitive impairment and language function impairment. It is used as a covariate to balance the groups (according to end-of-life status) with respect to a moderately large number of confounders whose effects on caries severity are not of direct interest. In the first negative binomial regression, we tested the association between dental caries severity and being in the last year of life adjusting for mobility, oral care capacity, and propensity of death; the interaction between end-of-life status and oral care capacity was included in the model. In the second analysis, we tested

this association again by adding all oral health measures into the model. Given that a large proportion of participants were long-term care residents, we also ran the third analysis based on the long-term care (LTC) residents only. The results of these analyses were very similar. To simplify the discussion, only the results of the first analysis are presented here. The data analyses were completed using SAS 9.2 (SAS Institute Inc., Cary, NC).

RESULTS

Characteristics of the study participants

On average, the end-of-life group survived 189.1 (SD=104.4) days after the new patient exam. Among them, 21.9% survived less than 3 months; 27.0% survived to 4–6 months; and 51.1% survived more than 6 months. The end-of-life group was older than the comparison group (84.7 vs. 80.8, $P<.001$, Table 1). The end-of-life group was also more likely to be male, have dental insurance coverage and reside in a nursing home.

The end-of-life participants had more chronic medical conditions and higher disease burden (CCI score) than the comparison group (Table 1). The overall drug-induced anticholinergic burden (sum of ADS scores) was similar in both groups. Cognitive and functional impairment was highly prevalent in the study participants, but was more prominent among those in the last year of life. Among the end-of-life participants, nearly 80% were cognitively-impaired; 70% required substantial help to be transferred into dental chairs, indicating moderate to severe functional impairment. Three quarters of the end-of-life participants needed help with oral hygiene, significantly higher than that in the comparison group ($P<.001$). Additionally, the end-of-life group was more likely to have difficulty to communicate their oral health needs with the dental providers during the new patient exams than the comparison group (45% vs. 24%, $P<.001$).

Oral health status of the study participants

Compared to the comparison group, the end-of-life group had a higher rate of edentulism (36% vs. 27%, $P=.02$, Table 1). On average, end-of-life participants had 6.4 carious teeth, significantly more than 4.9 in the comparison group ($P<.01$). However, dental caries severity was not associated with length of survival in the end-of-life group. Participants who died within 3 months after the baseline assessment had slightly more carious teeth (mean=7.5) than those who survived 4–6 (mean=5.0) and 7–12 (mean=6.9) months, but the difference was not significant ($P=.22$). There were no statistically significant differences according to end-of-life status in the number of teeth, number of filled teeth, oral hygiene/gingival inflammation or use of a removable dental prosthesis.

While caries severity increased with age in the comparison group, it peaked in the end-of-life participants aged 75–84 and slightly decreased in those aged 85 and above in the end-of-life group (Table 2). Caries severity didn't differ in the two groups among participants aged 65–74 and 85 and above. However, among those aged 75–84, end-of-life participants had more carious teeth than the comparison group ($P<.01$).

Dental caries, end of life status and oral care function

Multivariable analysis revealed that being in the last year of life ($P=0.03$), oral care capacity ($P<.001$), and their interaction ($P=0.02$) were significantly associated with caries severity. The incidence density ratios (IDRs) in Table 3 reveal the dominant role of oral care function. Specifically, compared to the reference group (functionally-independent participants not in the last year of life), participants with impaired oral care function, depending whether they were in the last year of life or not, had 1.57 (95% CI: 1.14–2.16) and 1.40 (95% CI: 1.15–1.70), respectively, times the number of carious teeth.

The impact of end-of-life status on caries severity differed in participants with and without impaired oral care function. Among participants who were dependent on caregivers for maintaining oral hygiene, end-of-life participants had only slightly elevated and non-statistically significant risk (7.5 vs. 6.1, adjusted IDR= 1.12, 95% CI=0.85–1.48) to have more carious teeth than those not in the last year of life, suggesting that oral health had declined before they entered in their last year of life. However, caries severity decreased among end-of-life participants without impaired oral care function compared to the reference group (IDR=0.53, 95% CI: 0.30–0.92).

DISCUSSION

The present study showed that increased caries severity in older adults in the last year of life is largely attributable to impaired oral care function. While being in the last year of life slightly (but not significantly) increased dental caries severity among participants needing help with oral hygiene, it appeared to lower the risk of dental caries among participants without impaired oral care function. The distinct impacts in different functional groups revealed that, in this dataset, oral care capacity was an effect modifier for the association between caries severity and end-of-life status. While the exact reason for this remains unknown, the lower dental caries severity in end-of-life participant without impaired oral care function might be related to factors that were not measured in this study. Evidence shows that older adults with regular dental visits are less likely to have untreated dental caries^{14,15}. Therefore, individuals who had recent treatment for dental caries prior to the new patient assessment might have fewer untreated carious teeth at the exam. In these data, the impact of dental care patterns might be most prominent in the end-of-life group without impaired oral care function.

On the other hand, the prolonged and slowly progressive course of functional decline in frail or demented persons might increase the risk of dental caries in end-of-life participants needing help with oral care. Frail older adults usually experience a gradual and progressive functional decline that may occur 2–3 years prior to death and increase as death approaches^{1,16,17}. Patients with cognitive impairment typically experience decline much earlier than those without cognitive impairment and are much more likely to require substantial caregiver support prior to death. Cognitive and functional impairment, together with inadequate caregiver support and lack of access to regular dental care, significantly escalate risk of dental caries in frail and cognitively-impaired individuals^{18–21}.

Highly-prevalent dental caries can compromise quality of life in end-of-life patients and also poses a great challenge for dental professionals. Although palliative care focusing on control of pain and infection is recommended for end-of-life patients, it is sometimes hard to implement this strategy in practice because reliable estimation of survival is difficult, especially for frail elderly whose end of life functional declines are usually lingering. Additionally, due to lack of clear guidelines, when to start palliative care in end-of-life patients is hardly evidence-based. Given that many end-of-life patients are medically-compromised, how to individualize dental treatment plans and determine appropriate treatment and intensity corresponding to patient's health status and tolerance is also challenging and requires comprehensive assessment, careful planning, and good communication between dental providers, medical professionals, patients and their families.

Given these concerns, effective preventive measures need to be considered for individuals nearing the end of life, especially for frail or demented older adults. For these individuals, individualized oral hygiene care plans and caregiver training programs corresponding to the patient's function and level of support should be developed. An effective preventive care plan including a shorter dental recall interval, appropriate use of topical fluorides, and

management of xerostomia should also be considered. Additionally, a large proportion of end-of-life individuals with cognitive impairment may lose their ability to report dentally-related pain, so educational programs to help caregivers recognize oral pain-related signs and behavioral changes should be established.

The lack of a uniform criterion for caries assessment was one of the major limitations in this study. To address this issue, we grouped dental caries and retained roots into one variable. While this approach was helpful to minimize the potential variations in recording caries, it did not fully address the possibility of misdiagnoses from the lack of uniform caries diagnostic criteria. The caries severity in the study participants could therefore have been mis-estimated.

Due to lack of a standardized instrument, dentists usually evaluated patient's oral care function based on patients' cognitive status, physical function, cooperation to care and oral/denture hygiene status. For cognitively-impaired patients, caregiver-perceived functional capacity may also be considered. While this approach has some limitations, given that oral/denture hygiene status was factored into the assessment, we are confident that this approach was acceptable. However, since there was no uniform standard used during the assessment, variation might present between examiners, which was one of the major limitations of this study.

Similarly, cognitive assessment was not based on standardized criteria, which might not have been completely accurate and could vary from provider to provider. To evaluate the quality of these data, we first examined the data of nursing home (NH) residents with dementia whose diagnoses of dementia were established by physicians, geriatricians and neurologists. This internal validation found that using these subjective approaches, the dentists in the study clinic identified that 97% of the NH patients with a diagnosis of dementia were cognitively impaired, indicating an acceptable reliability of this assessment. Additionally, based on dentists' assessments, 75% of the NH participants were cognitively impaired. This number is comparable to the results of a previous report indicating that 70% of Minnesota NH residents have cognitive impairment²². These internal validations suggested that the cognitive assessments provided by geriatric dentists in the study clinic were fairly reliable.

In conclusion, oral self care function modifies the association between caries severity and end-of-life status. The highly prevalent dental caries in functionally-impaired participants imply that oral health had declined in these individuals before entering in their last year of life. On the other hand, the decreased caries severity in end-of-life patients who could maintain oral hygiene independently suggests that if good oral care is maintained, older adults in the last year could still have a relatively low level of caries.

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Table 1

Sociodemographics of the study participants

	Comparison group (n = 1048)	End of life group (n = 168)	P-value
Sociodemographics			
Age (years), mean $\pm$ SD	80.79 $\pm$ 4.50	84.69 $\pm$ 7.96	<.001
Male, %	26.81	38.10	<.01
Having dental insurance, %	74.14	82.14	.03
Residential status, %			<.001
Community	34.38	10.71	
Assisted Living	6.02	5.95	
Nursing Home	59.60	83.33	
Medical and Functional Characteristics			
Charlson Comorbidity Index, mean $\pm$ SD	1.60 $\pm$ 1.37	2.46 $\pm$ 1.74	<.001
Number of medical conditions, mean $\pm$ SD	7.97 $\pm$ 4.92	10.77 $\pm$ 5.86	<.001
Number of medications, mean $\pm$ SD	7.39 $\pm$ 4.19	8.59 $\pm$ 4.20	<.001
Sum of ADS ^a , mean $\pm$ SD	2.07 $\pm$ 2.12	2.18 $\pm$ 1.90	0.54
Cognitive impairment, %			<.001
None	43.35	21.74	
Mild	32.19	41.61	
Moderate to severe	24.46	36.65	
Having communication problem, %	24.00	44.52	<.001
Physical mobility, %			<.001
Walk independently	33.98	10.90	
Need walker or wheel chair, but transfer independently	27.18	17.95	
Need help in transfer	38.13	67.95	
Bedridden	0.71	3.21	
Capacity to perform oral hygiene, %			<.001
Self sufficient	52.05	24.24	
Need supervision or help	46.49	73.33	
Patient won't cooperate	1.46	2.42	
Oral Health Characteristics			
Edentulism, %	26.81	35.71	.02
^b Number of teeth, mean $\pm$ SD	17.16 $\pm$ 7.86	17.30 $\pm$ 7.37	.86
^b Number of carious teeth, mean $\pm$ SD	4.85 $\pm$ 4.74	6.37 $\pm$ 5.69	<.01
^b Number of filled teeth, mean $\pm$ SD	9.15 $\pm$ 6.34	9.09 $\pm$ 6.28	.93
Use of a removable dental prosthesis, %	50.91	54.76	.35
^b Calculus/ Plaque / Gingival bleeding, %			.23
N/A	1.47	1.08	
None	0.74	0.00	

	Comparison group (n = 1048)	End of life group (n = 168)	P-value
Mild to Moderate	69.17	61.29	
Heavy	28.61	37.63	

^aADS, anticholinergic drug scale

^bDentate participants only

Table 2Number of carious teeth by age and end of life status, mean $\pm$ SD

Age (years)	Comparison group n = 1048	End of life group n = 168	P-value
65–74	4.20 $\pm$ 4.17	3.46 $\pm$ 5.27	.54
75–84	5.06 $\pm$ 4.73	7.39 $\pm$ 5.49	<.01
>84	5.27 $\pm$ 5.18	6.47 $\pm$ 5.79	.12

Table 3

Number of carious teeth, end of life status and oral care capacity

End of life status	Needs help with oral care	Number of carious teeth Mean $\pm$ SD	Unadjusted IDR (95% CI)	Adjusted IDR ^a (95% CI)
No	No	3.71 $\pm$ 4.22	1.00 (reference)	1.00 (reference)
No	Yes	6.05 $\pm$ 4.91	1.63 (1.41–1.89)	1.40 (1.15–1.70)
Yes	No	2.32 $\pm$ 3.14	0.63 (0.39–1.01)	0.53 (0.30–0.92)
Yes	Yes	7.45 $\pm$ 5.78	2.01(1.59–2.54)	1.57 (1.14–2.16)

^a based on negative binomial regression with end-of-life status, oral care capacity and their interaction as independent variables adjusting for mobility and propensity of death as additional covariates.