Investigation

Spending on emergency care due to nontraumatic dental conditions in the United States, 1996 through 2016

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ABSTRACT

Background. Emergency department (ED) use for oral health care is a growing problem in the United States. The objective of the study was to describe spending on ED visits due to nontraumatic dental conditions (NTDCs) in the United States and to quantify changes in spending and its drivers.

Methods. Spending estimates for ED visits due to NTDCs according to type of payer were analyzed for the period from 1996 through 2016 and estimates about the drivers of change were analyzed for the period from 1996 through 2013. NTDCs included caries, periodontitis, edentulism, and other oral disorders. Estimates were calculated according to age, sex, and type of payer (that is, public, private, and out of pocket), adjusted for inflation, and expressed in 2016 US dollars. The estimate of expenses was decomposed into 5 drivers for the period from 1996 through 2013 (that is, population, aging, prevalence of oral disorders, service use, and service price and intensity).

Results. The total change in spending from 1996 through 2016 amounted to $540 million, an increase of 216%. The drivers of changes in spending from 1996 through 2013 were price and intensity ($360 million), service use ($220 million), and population size ($68 million).

Conclusions. Spending on ED visits due to NTDCs more than tripled during the study period, with price and intensity representing the main drivers. This increase was primarily in adults and paid via the public sector.

Practical Implications. Possible solutions include strengthening the oral health care safety net, especially for the most vulnerable populations.

Key Words. Dental economics; public health dentistry; hospital emergency service; oral health.

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In the United States, oral health care expenditures constitute a relevant proportion of total health care spending. Researchers with the Disease Expenditure (DEX) Project from the the Institute for Health Metrics and Evaluation at the University of Washington estimated that the cost of oral health care amounted to $137 billion in 2016, of which $76 billion was spent to treat oral disorders (for example, caries, periodontitis, and edentulism) and $61 billion was spent in wellness oral health care (for example, malocclusion, routine examinations, and other expenses such as cosmetic dentistry).[1] This analysis also revealed that oral disorders were the group of health conditions with the highest proportion of out-of-pocket (OP) spending among all of those for which the DEX Project produced estimates; that is, approximately 40% of the expenses, equivalent to $30.5 billion in 2016. Moreover, public insurance spent $11.5 billion for oral disorders and $6.5 billion for wellness oral health care in the same year.[1]

According to estimates from the National Health Expenditures Account and reported by the Health Policy Institute of the American Dental Association, oral health care accounted for 4.5% of total health care spending across all payers in 2013.[2,3] Changes in prevalence of oral conditions over time should be among the primary considerations in planning for the provision of oral health care and might influence service use and oral health care spending.[4] For example, the decline in

prevalence of complete tooth loss will affect provision of oral health care because dentate adults are more likely to recognize a need for a dental visit than edentulous adults.[5,6]

Existing evidence supports that people with private dental insurance are more likely to visit the dentist. This is relevant because dental insurance coverage varies greatly across the United States according to age group. Eleven percent of children aged 2 through 18 years did not have dental insurance coverage in 2014, and 35.2% of adults aged 19 through 64 years and 62.0% of adults 65 years or older were uninsured in the same year.[7]

Furthermore, for most people in the United States, dental insurance coverage is job-based, meaning that those who are unemployed are most at risk of losing dental coverage and at highest risk of irregular dental service use.[8] This results in an unmet need for oral health care, particularly because oral health care coverage for adults under Medicaid is at the discretion of each state government. Although many states cover emergency oral health care for the relief of pain and infection, whether provided in a dental office or emergency department (ED), several other states cover emergency hospital care only.[9]

ED use for oral health care is a growing problem in the United States. From 2000 through 2010, use of EDs due to nontraumatic dental conditions (NTDCs) rose steadily, with an average annual increase of 4% from 1997 through 2007.[10] This is because the ED became the only possible source of oral health care for those who cannot obtain it otherwise or who have no oral health care coverage under public or private insurance.[11] The existing evidence suggests that treatment of NTDCs in EDs is palliative, generally provides symptomatic relief, and, in general, consists of prescriptions for antibiotics and analgesics. Existing evidence also indicates that the number of patients receiving this type of care increased from 1997 through 2007.[12]

It has also been reported that approximately 76% of ED dental visits by Medicaid patients were classified as nonurgent or semiurgent, meaning that they were likely to be diverted if oral health care was available in another place, such as a community-based setting or a dental school.[7] The investigators estimated that up to 1.65 million ED visits could be diverted out of hospital settings each year, resulting in substantial cost savings that could be used, for example, to fund Medicaid premiums or other more cost-effective interventions.[7] However, little information is available about the impact of the Patient Protection and Affordable Care Act (ACA) and the corresponding expansion of Medicaid on the number of visits to ED due to dental problems.[13] In Kentucky, 1 of 12 states that included dental coverage for adults as part of its Medicaid expansion, an increase in the number of ED visits for oral health care was observed after Medicaid expansion under the ACA, and associated costs more than tripled.[11] In Minnesota, contrary to Kentucky, a decrease of 9.7% in the number of ED visits for NTDCs from 2008 through 2014 was reported, with greater decreases observed for younger adults.[13]

Apart from the impact of service use, investigators who quantified the relative contribution of other drivers of change in spending for visits to EDs due to NTDCs have not assessed changes in the prevalence of oral disorders, population aging, and population growth. Also, to our knowledge, there are no studies that analyzed spending on ED visits due to NTDCs nationally during a period of 2 decades. The objective of our research was to systematically describe spending on ED visits due to NTDCs in the United States according to sex and age group and to quantify changes in spending and its drivers from 1996 through 2016.

ABBREVIATION KEY

ACA: Patient Protection and Affordable Care Act.
APC: Annual percentage change.
DEX: Disease Expenditure.
ED: Emergency department.
EDC: Emergency department care.
GBD: Global Burden of Disease.
NTDC: Nontraumatic dental condition.
OP: Out of pocket.

METHODS

The source of the estimates reported in our study is the DEX Project.[1,14] Spending estimates on ED visits due to NTDCs according to type of payer are available for the period from 1996 through 2016, and estimates about the drivers of change are available for the period from 1996 through 2013.

NTDCs are included among the 154 health conditions for which this project estimated costs. The group of oral disorders includes untreated caries of the primary and permanent dentition, periodontitis, edentulism, and other oral disorders.[15,16] In brief, estimates of oral disorders (for example, NTDCs) from the Global Burden of Disease (GBD) study were used. Data used to inform models for oral disorders were obtained from scientific articles and oral health surveys. Estimates of prevalence due to caries in primary and permanent teeth, periodontitis, edentulism, and other oral disorders were produced for the United States according to year, sex, and age using Dismod-MR 2.1, a Bayesian meta-regression framework developed for the GBD study.[16] In addition to the ED spending estimates, the DEX Project also estimated spending on inpatient, ambulatory, dental, retail

pharmaceutical, and nursing facility care, which are reported in our study for comparison. Estimates of spending on ED visits due to oral disorders were produced using data from the National Health Expenditures Account (1996-2020), Medical Expenditure Panel Survey (1996-2013), and MarketScan (2000, 2010, 2012). Encounter-level microdata were used to determine the amount of resources spent on each condition mapped and age groups and sex for each year from 1996 through 2016.[1,14] An encounter was defined as an interaction with the health care system that included ED visits. The estimates were calculated according to age, sex, and type of payer (public, private, OP), adjusted for inflation, and expressed in 2016 US dollars. Other methodological details of these estimates, including the explanations for their several adjustments, can be found in the DEX Project.[1]

The estimates of expenses for ED use due to NTDCs were decomposed into 5 key drivers, which are fundamental factors that constitute the spending for the period from 1996 through 2013 only.[14] In contrast, estimates of spending are available for a longer period, which ranges from 1996 through 2016.[1] Although there is little consensus about which factors are more responsible for increases in health care spending, the DEX Project has relied on prior studies that identified the following 5 different drivers: total US population, fraction of the population living in each age group and sex, disease prevalence, service use, and service price and intensity.[14] For ED visits, service use was measured as the mean visits per prevalent or incident case, and service price and intensity was the mean spending per visit.[14] Subsequently, each driver's relative contribution to the increase spent in the study period was estimated.[14] These drivers were population size, population aging, prevalence of oral disorders, service use, and service price and intensity. Service use was measured as the mean visits per prevalent case and service price and intensity were measured as the mean spending per visit; this driver also included the use of new technologies.[14] The demographic decomposition discussed by das Gupta[17] was applied to identify each of the 5 drivers' relative effect in changing spending on ED visits due to NTDCs from 1996 through 2013. This decomposition considers that the composition of spending has the following structure:

$$Spending_{a,s,c,t,y} = Pop_y \times \frac{Pop_{a,s,y}}{Pop_y} \times \frac{Cases_{a,s,c,y}}{Pop_{a,s,y}} \times \frac{Encounters_{a,s,c,t,y}}{Cases_{a,s,c,y}} \times \frac{Spending_{a,s,c,t,y}}{Encounters_{a,s,c,t,y}},$$

where a = age; s = sex; c = health condition; t = type of care; y = year; and Pop = population.[17]

Data on the burden of oral disorders were obtained from the GBD study. The GBD study is the most complete effort to measure the global burden of more than 300 diseases and health conditions, including oral disease prevalence, incidence, and disability according to age, sex, geography, and time. The methodological procedures to obtain the oral diseases estimates can be found in Kassebaum and colleagues.[18] To perform the decomposition analysis, epidemiologic and population data from the GBD study were combined with the DEX Project data.[14]

For the trend analysis of spending on ED due to NTDCs from 1996 through 2016, a generalized linear regression model was applied using the Prais-Winsten method. The dependent variable was the log-10–transformed spent and the independent variable was the year. The estimate of the annual percentage change (APC) and its 95% CI were obtained via the following equations recommended by Antunes and Waldman[19]:

$$APC = (-1 + 10^{b1}) * 100\%$$
$$95\%\ CI^{lower} = (-1 + 10^{b1lower}) * 100\%$$
$$95\%\ CI^{upper} = (-1 + 10^{b1upper}) * 100\%,$$

where *b1* is the regression coefficient and *b1lower* and *b1upper* are the upper and lower limits of its 95% CI, respectively. The trend is ascending if the APC and 95% CI are positive, and is declining if APC and 95% CI are negative, and stationary if the 95% CI includes 0.[19]

RESULTS

Table 1 presents the drivers of change in expenditures with ED visits due to oral disorders from 1996 through 2016. The total change in spending from 1996 through 2016 amounted to $540 million, or 216%, with higher percentage increases in adults and women. The drivers of changes in spending, available for the period from 1996 through 2013, were price and intensity ($360 million), service use ($220 million), and population size ($68 million). In addition, there was a reduction in spending due to population aging ($22 million).

Table 1. Total spent on emergency department care visits for nontraumatic dental conditions and the drivers of the change in spending, United States 1996-2016.

		ACCORDING TO AGE GROUP				ACCORDING TO SEX	
VARIABLE	**TOTAL**	**0-19 Y**	**20-44 Y**	**45-64 Y**	**≥65 Y**	**Male**	**Female**
1996 Spending*	0.25	0.04	0.13	0.05	0.02	0.12	0.13
2016 Spending*	0.79	0.09	0.46	0.17	0.06	0.36	0.42
Change in Spending, 1996-2016*	0.54	0.05	0.32	0.12	0.04	0.24	0.30
Change in Spending, 1996-2016 (%)	216.0	125.0	235.9	240.0	200.0	200.0	223.1
Drivers†							
Change in population size*	0.07	0.01	0.05	0.01	0.001	NA‡	NA
Change in population aging*	–0.03	–0.004	–0.04	0.01	0.001	NA	NA
Change in disease prevalence*	NA	0.003	–0.002	–0.001	NA	NA	NA
Change in service use*	0.22	0.02	0.18	0.02	0.003	NA	NA
Change in price and intensity*	0.36	0.03	0.25	0.07	0.01	NA	NA

* Values are in billions of US dollars. † Estimates about drivers are available for the period from 1996 through 2013, adjusted to 2016 US dollars; collected directly from the Disease Expenditure Project. ‡ NA: Not applicable.

Table 2. Annual percentage change (95% CI) in spending on emergency department care visits for nontraumatic dental conditions, according to type of spending and age group, United States 1996-2016.

VARIABLE	ANNUAL % CHANGE	95% CI	TREND
Type of Spending			
Public	7.05	5.77 to 8.34	Increasing
Private	4.55	3.41 to 5.70	Increasing
Out of pocket	0.23	–1.99 to 2.49	Stationary
Total	6.00	4.84 to 7.17	Increasing
Age Group, Y			
<20	3.96	2.63 to 5.31	Increasing
20-44	6.33	4.90 to 7.79	Increasing
45-64	6.59	5.91 to 7.27	Increasing
≥65	5.68	4.77 to 6.60	Increasing

The APC in spending for ED visits due to NTDCs varied according to payer (type of spending), with a total APC of 6.0% and an APC of 7.0% from public sources, 4.55% from private insurance, and 0.2% from OP. The APC was higher in adults than in younger and older people (Table 2). Figure 1 reveals a trend of increasing spending in the study period, with expenses of the public sector increasing expressively more than the others, and Figure 2 shows that this increase is concentrated in adults aged 20 through 44 years, irrespective of the type of payer. Figure 3 illustrates that the trends are similar according to sex, also irrespective of the type of payer, and Figure 4 indicates that the increase in per capita spending is concentrated in adults and according to public sector and private insurance. Finally, considering the spending due to oral disorders, the APC of ED was the highest among all types of care (Table 3). Although ED is not the largest dental expenditure, it was the one with the greatest percentage increase in the period from 1996 through 2016.

DISCUSSION

Spending on care in the ED due to NTDCs increased 216% from 1996 through 2016 in the United States, reaching almost $800 million in 2016. The annual rate of increase of emergency department care (EDC) spending due to dental conditions was considerably higher than in any other type of

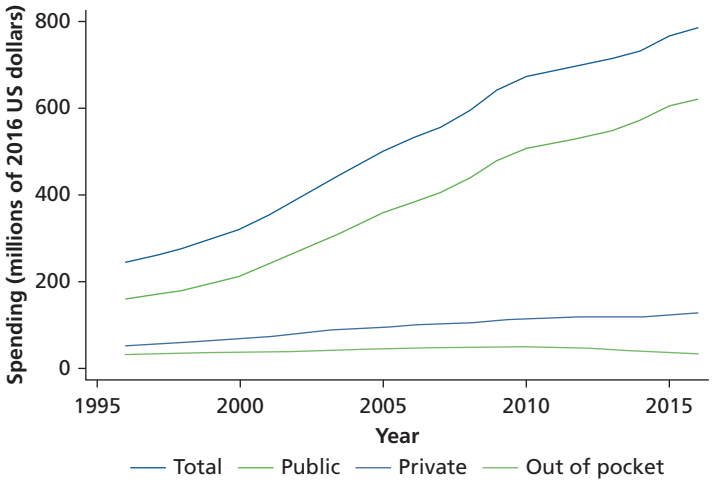

Figure 1. Spending on emergency department care visits for nontraumatic dental conditions (in millions of 2016 US dollars) per year, according to type of payer of spending, United States 1996-2016.

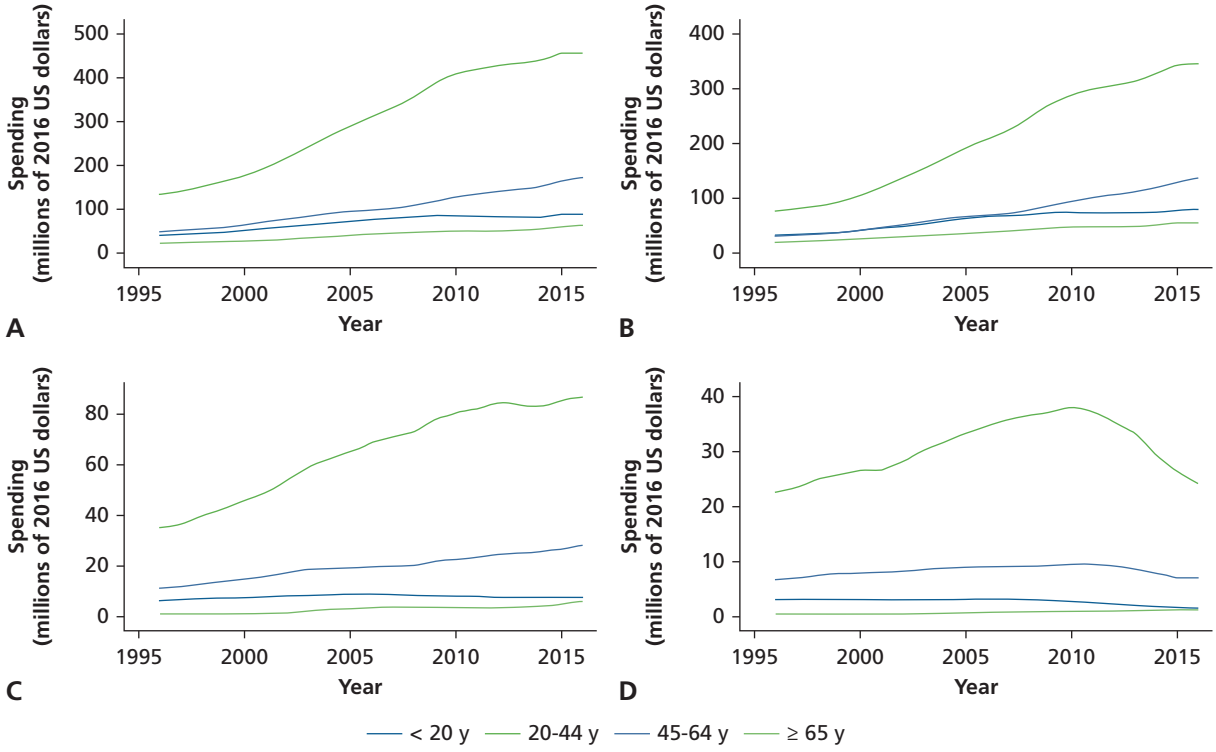

Figure 2. Spending on emergency department care visits due to nontraumatic dental conditions (in millions of 2016 US dollars) per year, according to type of payer of spending and age group, United States 1996-2016. **A.** All types of spending. **B.** Public spending. **C.** Private spending. **D.** Out-of-pocket spending.

care (6%; the second highest was ambulatory care at 3.9%), and the "price and intensity," that is, frequency and quantity of health care services needed and the fees paid to the facility and health professionals, was the main driver of this increase. Concerning the payer, public spending had the biggest increase. To our knowledge, our study is the first to analyze the temporal trends of EDC spending due to NTDCs in the United States, according to categories, type of payer, and the drivers of spending.

Our results are consistent with some previous analyses of ED visit rates due to dental conditions. Analyzing the data from the National Ambulatory Medical Care Survey, investigators compared the ED visit rate for dental-related problems with visit rates for asthma for the period from 2001 through 2008. The authors found a 59% increase in rates of ED visits due to dental conditions, the biggest

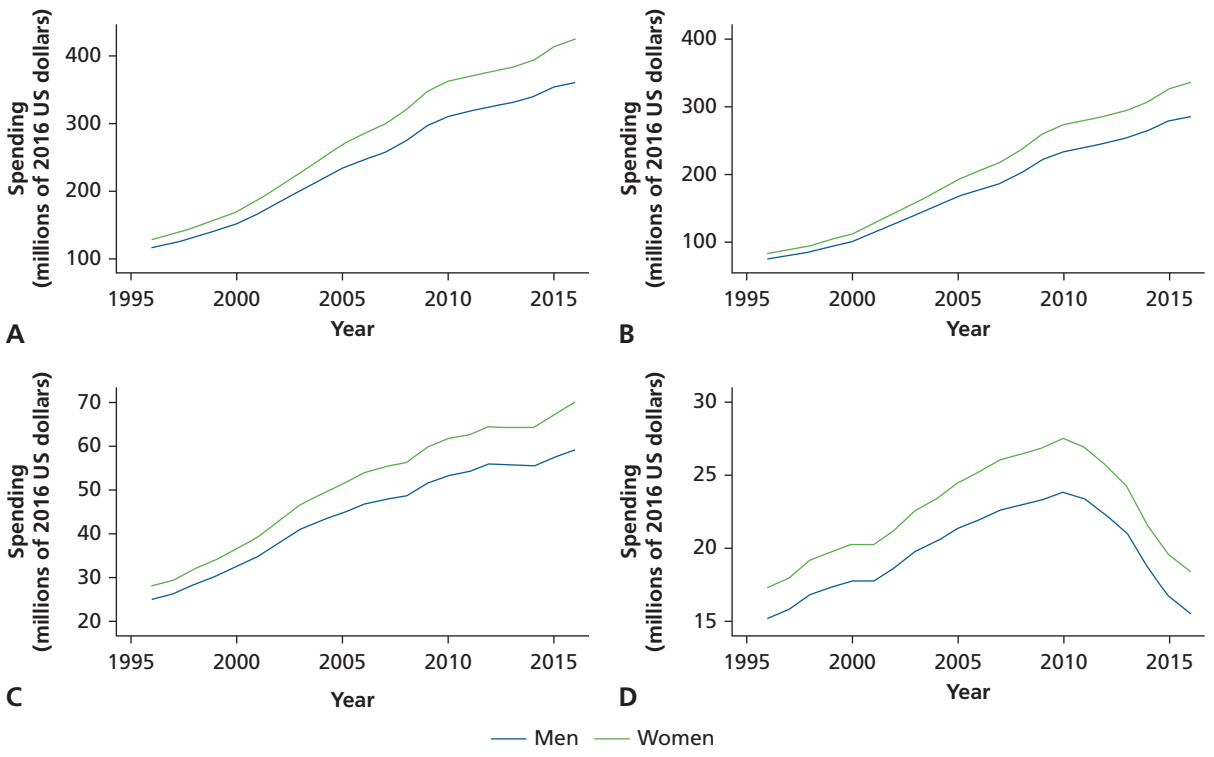

Figure 3. Spending on emergency department care visits due to nontraumatic dental conditions (in millions of 2016 US dollars) per year, according to type of payer of spending and sex, United States, 1996-2016. **A.** All types of spending. **B.** Public spending. **C.** Private spending. **D.** Out-of-pocket spending.

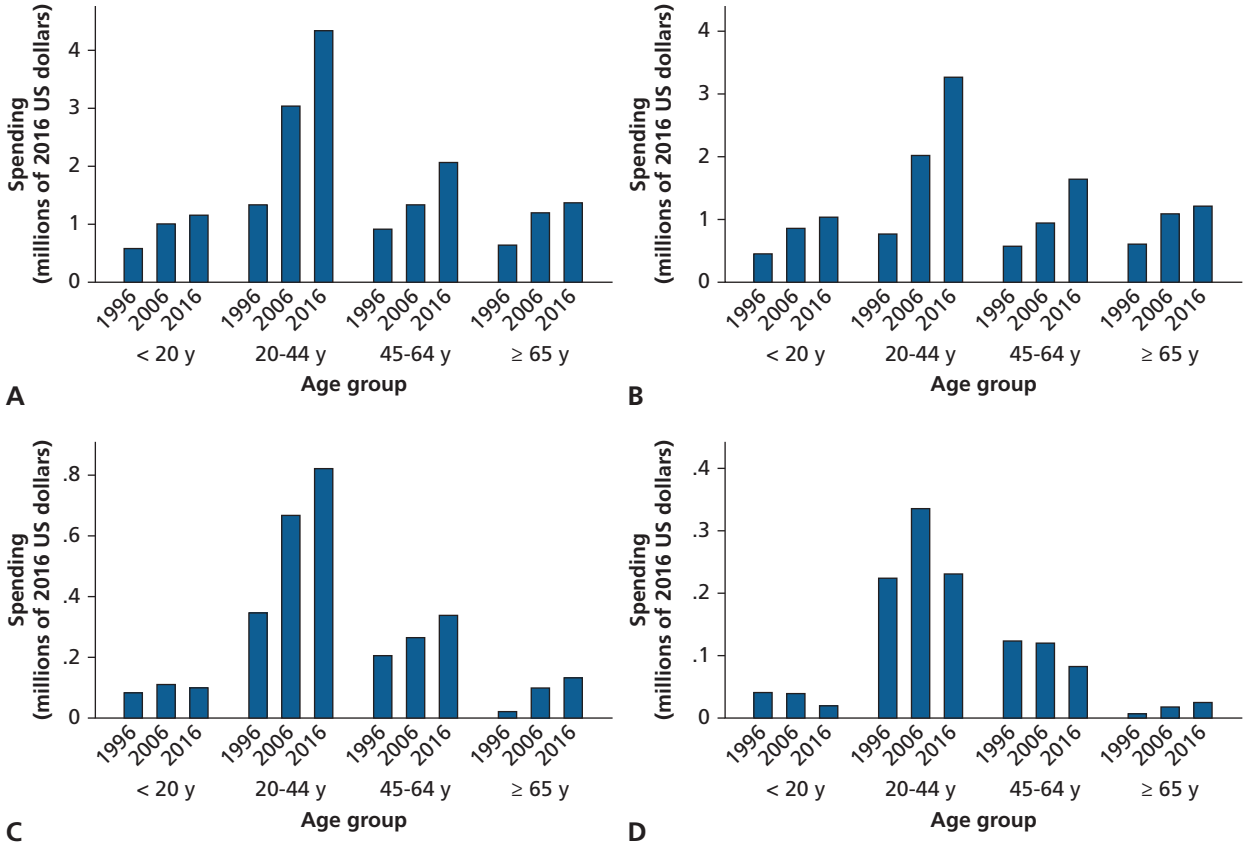

Figure 4. Per capita spending on emergency department care visits due to nontraumatic dental conditions (in millions of 2016 US dollars) in 1996, 2006, and 2016, according to type of payer of spending and age group, United States, 1996-2016. **A.** Total spending. **B.** Public spending. **C.** Private spending. **D.** Out-of-pocket spending.

Table 3. Spending on oral disorders according to type of care, changes in the spending, and annual percentage change (95% CI) in spending, United States 1996-2016.

	SPENDING*		CHANGE IN SPENDING			
VARIABLE	1996	2016	1996-2016*	1996-2016, %	ANNUAL % CHANGE (95% CI)	TREND
Total	74,174.6	136,966	62,792	84.7	3.11 (2.10 to 4.12)	Increasing
Type of Care						
Ambulatory care	506.2	1,081.1	574.0	113.6	3.9 (3.1 to 4.7)	Increasing
Oral health care	67,441.2	123,714.0	56,272.0	83.4	3.0 (2.1 to 4.1)	Increasing
Emergency department care	245.4	785.5	540.1	220.1	6.0 (4.8 to 7.2)	Increasing
Inpatient care	679.3	1,188.0	508.7	74.9	2.8 (1.6 to 4.1)	Increasing
Nursing facility care	17.3	27.6	10.3	60.0	2.4 (2.2 to 2.6)	Increasing
Prescribed pharmaceutical care	451.0	525.9	74.9	16.6	0.5 (–3.9 to 5.1)	Stationary

* Values are in millions of 2016 US dollars, adjusted for inflation.

among uninsured young adults and Black people, and rates of visits due to asthma did not change during the study period.[20] Other studies that analyzed data according to states also reported a similar pattern of growth in the rate of visits to EDs due to NTDCs.[21-23] In another study, investigators used the National Ambulatory Medical Care Survey data set and found that the rate of ED visits for dental-related problems rose from 4.2 per 100,000 inhabitants from 1997 through 1998 to 7.5 per 100,000 inhabitants from 2007 through 2008, with an estimated total of 2.24 million hospital-based emergency visits due to NTDCs from 2007 through 2008.[24] The authors of the study concluded that part of the increase could be attributed to population growth; however, they did not analyze the drivers of change.[24] In our study, we identified that population growth had a slight influence on the increase in spending in EDC due to NTDCs and that the main driver of this increase was price and intensity, or the average spent per visit. From 1996 through 2013, price and intensity accounted for $360 million of the increase in spending, and service use accounted for $220 million.

The increase in spending reported, especially public spending, with ED-based treatment of NTDCs is an issue of concern because it represents temporary, ineffective care.[25] The results of our study indicate that ED care due to NTDCs is not only becoming increasingly expensive with no signs of stability but is also used more frequently. Researchers have reported that, on average, treating a patient for dental pain in an ED costs 4 times more than in a dental office.[12] In 2010, the national average cost of each visit to an ED due to dental-related problems was approximately $760[26]; in Florida, in 2014, it was $1,430.40.[21] In New York, from 2009 through 2013, the average cost of an appointment for dental conditions in EDs was approximately $1,042 when the primary payer was Medicare, $874 for private insurance, $811 for Medicaid, and $796 for OP.[27]

There is empirical evidence that emergency consultations are not usually the definitive solution for dental problems, even in nonhospital dental services that are more prepared for dental procedures than the ED.[28] Researchers studying emergency dental appointments (in a dental office or similar facility on an urgent or emergency basis) among Medicaid enrollees from 2016 through 2017 found that 78% of these patients revisited a dentist in the following year; of these, 43% returned for dental treatment and 20% were seen for a dental emergency again. The researchers also indicated that the ED route could lead to a vicious cycle of visits, probably due to unresolved demands.[28] Researchers in Minnesota reported that 20% of patients who visit EDs for dental-related problems return for this type of service 2 through 11 times within the following year, with demands of the same nature.[25] In many cases, ED visits due to NTDCs tend to be evaluative and associated with prescription drugs for pain control (primarily opioids) and infection, which act as a transitory solution to the problem.[12] Approximately 74% of patients who have been in EDs for NTDCs in the United States (1997-2007) received at least 1 analgesic prescription and 56% at least 1 antibiotic prescription.[12] In addition, the proportion of patients who received any of these medications increased considerably during the study period, contributing to the opioid crisis.[12]

The increase in spending from 1996 through 2016 (216%, adjusted for inflation) that was found for the United States was consistent with findings from a study in which researchers analyzed data from Florida. Spending on dental-related visits to Florida's EDs went from $47.7 million in 2005 to $193.4 million in 2014 (or $234.4 million if the reference was 2014 US dollars).[21] The authors argued that the use of EDs for dental problems represents an important source of public expenditure, which was the leading funder of these services in the period under analysis.[21] This was also true in our study. Considering that Medicare only provides reimbursement for oral health care under limited circumstances, it is highly likely that the observed increase in public expenses was covered by Medicaid. Furthermore, our findings are in line with those from a study in which investigators revealed a 3-fold increase in ED visits due to dental and oral health from 2010 through 2014, after implementation of the ACA.[11] Similarly, our results showed that reductions in OP spending coincided with the start of the ACA in 2010 and the expansion of benefits that followed. This is plausible because ED use for NTDCs is common in uninsured patients, the segment of the population who benefited from the ACA.

Since 1986, it has been mandatory in the United States that all patients who enter an ED receive at least the minimum necessary care, regardless of their ability to pay for it.[21] In this setting, the use of EDs for emergency dental service is a symptom of the lack of access to other sources of care that would be adequate, equipped, and familiar with resolution of the emergent situation. Faced with various barriers to accessing oral health care in environments suited to resolving the etiology of acute dental-related pain and infection, patients seek the ED as one of the few health care alternatives accessible to them. In addition, as reported in our study and previous studies, working-age adults use the ED alternative increasingly, suggesting the absence of a preventive network for oral diseases for these patients.[20,24,27] In summary, expenditures on EDC due to NTDCs are not effective and represent a growing source of public health expenditure that is not justified. The debate to expand Medicare benefits to include dental services may also contribute to addressing this problem by means of increasing access and use.

The limitations of our study have been described previously in detail in the DEX Project, which reported expenditures for health care overall and included problems with the data used to estimate health expenditures, specifically the Medical Expenditure Panel Survey, which excludes some segments of the populations, such as active military personnel and imprisoned people.[1] In addition, the adjustments and modeling are as satisfactory as the available underlying data. We were unable to estimate spending according to geography (for example, states), income band, race and other socioeconomic variables, or associated with the 2 main public insurance programs—Medicaid and Medicare. The fact that public payers often pay lower prices than private or OP payers means that performing the analysis of drivers of change according to type of payer could have yielded important insights. An additional limitation is that estimates were calculated using primary data up through 2013, meaning that estimates for the period from 2014 through 2016 were generated using data from previous years and are prone to bias. The results need to be interpreted considering the fact that the period for drivers of change only goes up through 2013. This is especially important because the health care system is dynamic and patterns may have changed in the years since. Finally, although we argued that ED visits are not effective on the basis of prior evidence, we cannot make claims about the effectiveness of the spending on NTDCs.[28]

CONCLUSIONS

Estimates of spending on ED visits for NTDCs indicated that expenditures more than tripled during the study period, with price and intensity, followed by use, representing the main drivers. This increase was seen primarily in adults of working age and paid via the public sector. These findings have implications for oral health care provision, especially that financed via the public sector, considering that prior evidence supports that most ED dental visits could be diverted to nonurgent or semiurgent, less expensive, and more effective, oral health care. ■

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1. Dieleman JL, Cao J, Chapin A, et al. US health care spending by payer and health condition, 1996-2016. *JAMA*. 2020;323(9):863-884.

2. Wall T, Guay A. The per-patient cost of dental care, 2013: a look under the hood. Health Policy Institute Research Brief. American Dental Association. Published March 2016. Accessed May 14, 2022. https://www.ada.org/-/media/project/ada-organization/ada/ada-org/files/resources/research/hpi/hpibrief_0316_4.pdf

3. The National Health Expenditure Accounts. Historical. Centers for Medicare & Medicaid Services. Published 2020. Accessed March 1, 2022. https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical

4. Rozier RG, White BA, Slade GD. Trends in oral diseases in the U.S. population. *J Dent Educ*. 2017;81(8):eS97-eS109. https://doi.org/10.21815/JDE.017.016

5. Slade GD, Akinkugbe AA, Sanders AE. Projections of U.S. edentulism prevalence following 5 decades of decline. *J Dent Res*. 2014;93(10):959-965.

6. Macek MD, Cohen LA, Reid BC, Manski RJ. Dental visits among older U.S. adults, 1999. *JADA*. 2004;135(8):1154-1162.

7. Wall T, Kamyar MBA, Vujicic M. *Majority of Dental-Related Emergency Department Visits Lack Urgency and Can Be Diverted to Dental Offices*. American Dental Association Health Policy Institute; 2014.

8. Manski RJ, Moeller JF, St Clair PA, Schimmel J, Chen H, Pepper JV. The influence of changes in dental care coverage on dental care utilization among retirees and near-retirees in the United States, 2004–2006. *Am J Public Health*. 2011;101(10):1882-1891.

9. Decker SL, Lipton BJ. Do Medicaid benefit expansions have teeth? The effect of Medicaid adult dental coverage on the use of dental services and oral health. *J Health Econ*. 2015;44:212-225.

10. National Center for Health Statistics. *Health, United States, 2012: With Special Feature on Emergency Care*. National Center for Health Statistics; 2013.

11. Chalmers N, Grover J, Compton R. After Medicaid expansion in Kentucky, use of hospital emergency departments for dental conditions increased. *Health Aff (Millwood)*. 2016;35(12):2268-2276.

12. Okunseri C, Okunseri E, Thorpe JM, Xiang Q, Szabo A. Medications prescribed in emergency departments for nontraumatic dental condition visits in the United States. *Med Care*. 2012;50(6):508-512.

13. Laniado N, Badner VM, Silver EJ. Expanded Medicaid dental coverage under the Affordable Care Act: an analysis of Minnesota emergency department visits. *J Public Health Dent*. 2017;77(4):344-349.

14. Dieleman JL, Squires E, Bui AL, et al. Factors associated with increases in US health care spending, 1996-2013. *JAMA*. 2017;318(17):1668-1678.

15. Stevens GA, Alkema L, Black RE, et al.; (The GATHER Working Group). Guidelines for accurate and transparent health estimates reporting: the GATHER statement. *Lancet*. 2016;388(10062):e19-e23. https://doi.org/10.1016/S0140-6736(16)30388-9

16. Bernabe E, Marcenes W, Hernandez CR, et al.; GBD 2017 Oral Disorders Collaborators. Global, regional, and national levels and trends in burden of oral conditions from 1990 to 2017: a systematic analysis for the Global Burden of Disease 2017 Study. *J Dent Res*. 2020;99(4):362-373.

17. das Gupta P. Decomposition of the difference between two rates and its consistency when more than two populations are involved. *Math Popul Stud*. 1991;3(2):105-125.

18. Kassebaum NJ, Smith AGC, Bernabé E, et al.; GBD 2015 Oral Health Collaborators. Global, regional, and national prevalence, incidence, and disability-adjusted life years for oral conditions for 195 countries, 1990-2015: a systematic analysis for the global burden of diseases, injuries, and risk factors. *J Dent Res*. 2017;96(4):380-387.

19. Antunes JLF, Waldman EA. Trends and spatial distribution of deaths of children aged 12-60 months in São Paulo, Brazil, 1980-98. *Bull World Health Organ*. 2002;80(5):391-398.

20. Lee HH, Lewis CW, Saltzman B, Starks H. Visiting the emergency department for dental problems: trends in utilization, 2001 to 2008. *Am J Public Health*. 2012;102(11):e77-e83. https://doi.org/10.2105/AJPH.2012.300965

21. Tomar SL, Carden DL, Dodd VJ, Catalanotto FA, Herndon JB. Trends in dental-related use of hospital emergency departments in Florida. *J Public Health Dent*. 2016;76(3):249-257.

22. Anderson L, Cherala S, Traore E, Martin NR. Utilization of hospital emergency departments for non-traumatic dental care in New Hampshire, 2001-2008. *J Community Health*. 2011;36:513-516.

23. Zhou W, Kim P, Shen JJ, Greenway J, Ditmyer M. Preventable emergency department visits for non-traumatic dental conditions: trends and disparities in Nevada, 2009-2015. *Am J Public Health*. 2018;108(3):369-371.

24. Wall T. Recent trends in dental emergency department visits in the United States: 1997/1998 to 2007/2008. *J Public Health Dent*. 2012;72(3):216-220.

25. Davis EE, Deinard AS, Maïga EWH. Doctor, my tooth hurts: the costs of incomplete dental care in the emergency room. *J Public Health Dent*. 2010;70(3):205-210.

26. Allareddy V, Rampa S, Lee MK, Allareddy V, Nalliah RP. Hospital-based emergency department visits involving dental conditions: profile and predictors of poor outcomes and resource utilization. *JADA*. 2014;145(4):331-337.

27. Rampa S, Wilson FA, Wang H, Wehbi NK, Smith L, Allareddy V. Hospital-based emergency department visits with dental conditions: impact of the Medicaid reimbursement fee for dental services in New York State, 2009-2013. *J Evid Based Dent Pract*. 2018;18(2):119-129.

28. Fiehn R, Okunev I, Bayham M, Barefoot S, Tranby EP. Emergency and urgent dental visits among Medicaid enrollees from 2013 to 2017. *BMC Oral Health*. 2020;20:355.