Costs of Medically Treated Craniofacial Conditions

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SYNOPSIS

Objectives. Determining the magnitude of the burden of diseases and health disorders on the U.S. population is a high priority for health policy makers. Conditions such as malignant neoplasms and injuries from craniofacial trauma contribute to adverse oral health. This study estimates the number of cases of diseases and disorders relevant to oral health that are treated annually in the medical care, as opposed to the dental care, system and associated costs. Policy makers can use this cost model to compare the impact of different conditions, to target areas for reducing costs, and to allocate appropriate health resources.

Methods. Data from four national and two state data systems were used to estimate the number of cases of selected dental, oral, and craniofacial diseases and conditions treated in the medical system annually and associated medical and wage/household work loss costs.

Results. Per case, the most costly conditions were estimated to be malignant neoplasms at $83,080 annually (in 1999 dollars), diabetes-related oral conditions at $51,030, endocarditis at $48,610, and chlamydiae at $41,100. Total estimated costs for oral conditions treated in the medical care system in 1996 were approximately $95.9 billion, including $21.4 billion in medical costs and $74.4 billion in wage/household work loss costs.

Conclusions. Conditions treated outside the dental care system are major contributors to oral health costs. They should be an important focus for the National Institute of Dental and Craniofacial Research.

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Determining the magnitude of the burden of diseases and health disorders on the U.S. population is a high priority for health policy makers. For the present study, several data systems were used to determine the costs of illness associated with a set of diseases and disorders relevant to oral health, in terms of both number of individuals affected and costs. While dental caries (decay) is the most prevalent oral disease affecting individuals throughout their life spans, other conditions included under the rubric of craniofacial disorders—such as diseases of the oral cavity, salivary glands, and jaws; malignant neoplasms of the lip, oral cavity, and pharynx; cleft palate and lip; congenital ectodermal dysplasia; Sjögren's disease (sicca syndrome); trigeminal neuralgia; candidiasis; and injuries related to craniofacial trauma—are also important oral health problems. Information on the number of cases and costs associated with these craniofacial diseases and conditions can be used by policy makers to compare the impact of specific conditions and to allocate appropriate health resources. The objective of this study was to estimate the incidence and costs of dental and craniofacial diseases, disorders, and injuries treated in the medical care, as opposed to the dental care, system. Collectively, we refer to these conditions as craniofacial conditions. By combining data from several sources, we estimate number of cases, medical costs, and costs associated with wage/household work loss.

METHODS

This section discusses the datasets used for this analysis and the methods for grouping conditions and estimating costs. Figure 1 lists the dental, oral, and craniofacial diseases and conditions considered (referred to collectively in the text as craniofacial conditions) and their associated International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM) codes.[1]

Data systems

Data from five sources were used to estimate the prevalence of and medical and wage/household work loss costs associated with selected craniofacial conditions.

National Health Interview Survey (NHIS). This National Center for Health Statistics (NCHS) survey annually polls 45,000 households that include more than 100,000 people.[2–8] Respondents are asked to identify any condition, illness, or injury that causes certain types of impacts associated with health, such as a visit to a doctor or limitations in usual activities. Respondents are then read lists of selected chronic conditions and asked whether they or any family members have any of these conditions. NCHS generated ICD-9-CM codes for each condition. Data on 6,998 non-hospital-admitted cases were pooled from the NHIS surveys conducted from 1990 through 1996. These data include a person's age, sex, self-reported diagnosis, level of medical treatment, employment status, work-loss days, bed days, and other restricted activity days resulting from the condition.

National Hospital Discharge Survey (NHDS). This annual NCHS survey obtains information on approximately 200,000 hospital discharges annually. The 1990–1996 data yielded 77,294 unweighted discharges for diagnoses related to craniofacial conditions.[9] We included all cases for which at least one discharge diagnosis was included in the list of craniofacial ICD-9-CM codes shown in Figure 1.

National Medical Expenditure Survey (NMES). NMES is conducted by the Agency for Healthcare Research and Quality. When we began our analysis, NMES offered the most recent nationally or regionally representative data describing prescription, home health, non-medical therapy, other ancillary expenses, and costs per ambulance transport. The 1987 survey used a national probability sample of 14,000 households that included about 35,000 people.[10] NMES obtains data from both the households and their medical providers. The survey captures diagnoses in ICD-9-CM from provider records. Expenditures for outpatient visits are reported in NMES data in three ways: (*a*) when charges are only partially paid by third-party payers such as insurers and Medicare, expenditures equal all payments including patient co-payments; (*b*) when there is no explicit charge for medical services, for example, when services are provided by governments, charities, or HMOs, NMES imputes a cost from the expenses associated with similar services; and (*c*) otherwise, expenses are represented by charges.

Civilian Health and Medical Program of the Uniformed Services (CHAMPUS). CHAMPUS reimbursement summaries for the years 1992–1994 describe medical service utilization, reimbursements, and self-payments for approximately two million civilian military dependents and retirees.[11] CHAMPUS is the most representative data source available for current information on physician payments associated with hospital care or diagnosis-specific costs of visits to physicians. It excludes Veterans Administration hospital treatment and on-base medical care. Restriction to three digits limits the ICD-9 diagnostic detail available. Miller, Pindus, Douglass, and Rossman found that the mean CHAMPUS medical payment per outpatient visit was virtually identical to the national mean estimate from the 1987 NMES.[12]

Figure 1. International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes for craniofacial conditions

ICD-9-CM code	*Condition*
032.1	Diphtheria
053	Herpes zoster
054.2	Herpetic gingivostomatitis
074.3	Hand, foot, and mouth disease
078.4	Foot and mouth disease
078.5	Cytomegaloviral disease
101	Vincent's angina
112.0	Candidiasis of mouth
140	Malignant neoplasm of lip
141	Malignant neoplasm of tongue
142	Malignant neoplasm of major salivary glands
143	Malignant neoplasm of gum
144	Malignant neoplasm of floor of mouth
145	Malignant neoplasm of other and unspecified parts of mouth
146	Malignant neoplasm of oropharynx
147	Malignant neoplasm of nasopharynx
148	Malignant neoplasm of hypopharynx
149	Malignant neoplasm of other and ill-defined sites within the lip, oral cavity, and pharynx
195.0	Malignant neoplasm of ill-defined sites: head, face, and neck
196.0	Secondary/unspecified malignant neoplasm lymph nodes: head, face, and neck
210	Benign neoplasm of lip, oral cavity, and pharynx
213.0	Benign neoplasm of bones of skull and face
213.1	Benign neoplasm of bones of lower jaw bone
215.0	Other benign neoplasm of connective and other soft tissue
216.0	Benign neoplasm skin of lip
230.0	Carcinoma in situ—lip, oral cavity, and pharynx
250.6	Diabetes with neurological manifestations
270.2	Other disturbances of aromatic amino-acid metabolism
350.1	Trigeminal neuralgia
350.2	Atypical face pain
421	Acute and subacute endocarditis
520	Diseases of tooth development and eruption
521	Diseases of hard tissues of teeth
522	Diseases of pulp and periapical tissues
523	Gingival and periodontal diseases
524	Dentofacial anomalies including malocclusion
525	Other diseases and conditions of the teeth and supporting structures
526	Diseases of the jaws
527	Diseases of the salivary glands
528	Diseases of the oral soft tissues excluding lesions specific for gingiva and tongue
529	Diseases and other conditions of the tongue
697.0	Lichen planus
710.2	Sicca syndrome
731.0	Osteitis deformans without mention of bone tumor
744	Congenital anomalies of ear, face, and neck
749.0	Cleft palate
749.1	Cleft lip
749.2	Cleft palate with cleft lip
750.0	Tongue tie
750.1	Other anomalies of tongue
750.2	Other specified anomalies of mouth and pharynx
754.0	Congenital musculoskeletal deformities of skull, face, and jaw
755.55	Apert's syndrome
756.0	Anomalies of skull and face bones
756.51	Osteogenesis—imperfecta
756.52	Osteopetrosis
757.31	Congenital ectodermal dysplasia
784	Symptoms involving head and neck
787.2	Dysphagia
792.4	Nonspecific abnormal findings in other body substances: saliva
802.0	Fracture of nasal bones, closed
802.1	Fracture of nasal bones, open
802.2	Fracture of mandible, closed
802.3	Fracture of mandible, open
830	Dislocation of jaw
848.1	Jaw sprain and strain
873.4	Open wound of face
873.5	Open wound of face—complicated
873.6	Open wound of mouth (internal)
873.7	Open wound of mouth (internal)—complicated
874.4	Open wound of pharynx
874.5	Open wound of pharynx—complicated

State-level hospital discharge data. We pooled hospital discharge surveillance data from two states: Maryland for 1994–1995 and New York for 1994. Like NHDS data, pooled state data include information on length of stay and patient demographics. They also include information on hospital care costs, as opposed to charges. Data were obtained from the Maryland Health Services Cost Review Commission and the New York State Department of Health Statewide Planning and Research Cooperative System (SPARCS).

Diagnosis and diagnostic groupings

Some of the data systems used in the analysis had small sample sizes, which resulted in low counts in some diagnosis groups. To ensure statistically reliable cost estimates, similar diagnosis categories were grouped together in the datasets used to calculate the average medical cost by condition. First, ICD-9-CM codes were collapsed from the five-digit level to the three-digit level. Three-digit diagnoses with fewer than 30 observations were further grouped with similar diagnoses. Average medical costs were calculated for each diagnosis group, and then these costs were applied to every diagnosis in the group. Diagnoses are then reported at the most detailed level.

Cases and cost estimation

Cases. For each craniofacial condition, the annual number of inpatient hospital admissions came from NHDS. The annual number of outpatient visits and the number of people treated during the year came from NHIS. The annual estimates for both data systems are averages computed by dividing aggregate counts over the seven-year period (1990–1996) by seven.

Medical costs for inpatient visits. Inpatient costs were estimated for each condition as the cost per hospital day multiplied by the average length of stay multiplied by the number of admissions. Length of stay was computed from cases in which a craniofacial condition was the primary diagnosis. Sensitivity analysis examined the effect of applying inpatient cost estimates under three options: Option 1 (upper bound), all hospital cases; Option 2, hospital cases in which a craniofacial condition was indicated in the first four diagnoses; and Option 3 (lower bound), hospital cases in which a craniofacial condition was indicated in the primary diagnosis field. Under the latter two options, outpatient cost estimates were applied to hospital cases for which craniofacial conditions were not indicated in the first four diagnosis fields. Results from Option 2 are presented here. Costs per hospital day, including professional fees, were computed from 1994 New York and 1994–1995 Maryland data. These data sources describe all hospital discharges in these states for those years (in total, about two million discharges). Only these two states require hospitals to publicly and accurately report their costs by hospital service (e.g., oncology, neurology, pediatrics). Furthermore, in these states average payments equal average costs; elsewhere, neither charges nor payments systematically relate to costs.[13] The discharge data in these states indicate illness or injury diagnoses. Costs were calculated for primary diagnosis and price-adjusted from state to national estimates.[13]

Medical costs for outpatient visits. The medical cost per outpatient emergency room, physician, or clinic visit was determined from 1992–1994 CHAMPUS payment summaries. CHAMPUS summaries exclude pharmacy, allied health professional, or ancillary costs (e.g., for medical devices). These costs were developed from NMES data using percentage distributions of medical spending by broad diagnosis groups and added to the CHAMPUS cost estimates.

Annual medical spending. The number of outpatient visits by condition from NHIS data was multiplied by the average cost of outpatient treatment by condition to compute total outpatient spending. Total inpatient spending is the product of the number of hospitalizations by diagnosis from NHDS data and the cost of an inpatient stay. Total national medical spending is the sum of the inpatient and outpatient totals. Cost per case, the cost of an episode of care to a maximum of one year of treatment for a condition, is the total cost divided by the number of people treated.

Wage and household work loss costs. To compute morbidity-related wage/household work loss costs, the number of days lost per person during a one-year period was estimated using NHIS data and then multiplied by the average cost per day. We assumed that a caregiver lost a wage work day whenever a child had a bed day or a day in the hospital. The daily wage was computed by dividing annual wages by 365 days, a method that implicitly accounts for work not being lost on scheduled days off. We assume bed days equate to days of household work lost.

For hospital admissions, we estimated wage work lost from NHDS data by multiplying length of stay times the ratio of work days lost to hospital days for motor vehicle victims whose most serious injuries were facial injuries. According to 1995–1998 Crashworthiness Data System data, that ratio is 4.0.[14] The days lost were multiplied by NHIS probabilities of being employed by diagnosis. Household work days lost were

computed from wage work days lost by multiplying by 365 days per year divided by 243 work days per year. The estimate of average daily cost of work lost was computed from published national statistics about the loss per day of wage work (including fringe benefits) and household work by age and sex.[15]

RESULTS

Number of cases

Annually, 3.6 million craniofacial cases were treated in the medical system. Approximately 1.4% of the U.S. population was treated.[16] Average annual rates for medically treated craniofacial conditions by type of condition are shown in Table 1. Rates range from 11 per 100,000 U.S. population to 715 per 100,000 population. The five highest rates per 100,000 were: symptoms of the head and neck (715), injuries (120), diseases of the tooth and gum (118), diabetes-related conditions (87), and herpes (59).

Medical costs

Estimated average annual medical expenditures for craniofacial conditions totaled $21.4 billion, in 1999 dollars (summed from Table 2), with a sensitivity analysis range of $8 billion to $27 billion (Options 1 and 3; details available from the authors). Diabetes was responsible for the highest medical costs ($3.1 billion). Among the 14 grouped categories, the other highest expenditures (in billions) were as follows: symptoms of the head and neck ($3.0), injury ($2.6), diseases of the tooth and gum ($2.4), and malignant neoplasms ($2.4). Table 3 shows that the conditions with the highest estimated medical cost per case were endocarditis ($39,100), selected viral-related conditions and chlamydiae ($25,390), malignant neoplasms ($19,310), candidiasis of the mouth ($14,150), and diabetes-related conditions ($13,890).

Wage/household work loss

Annually, the estimated wage/household workloss cost totaled $74.4 billion (Table 2). These costs varied by type of condition. The highest cost was associated with symptoms of the head and neck ($34.1 billion). Diabetes-related conditions and injury were next, each accounting for $8.3 billion dollars, followed by $7.9 billion for malignant neoplasms. As shown in Table 3, estimated wage/household work loss per case was highest for malignant neoplasms ($63,770), diabetes-related conditions ($37,140), viral-related and herpes ($29,080), benign neoplasms ($28,530), and injury ($26,820).

Table 1. Estimated number of craniofacial conditions and rates per 100,000 population

Disease/condition/injury group	*Number of cases*	*Rate per 100,000*
Herpes (053.0, 054.2)	150,621	58.5
Selected viral-related and chlamydiae (074.3, 078.4, 078.5)	30,001	11.6
Candidiasis of the mouth (112.0)	116,237	45.1
Malignant neoplasms (140–149, 195, 196)	123,848	48.1
Benign neoplasms (210, 213, 215, 216)	27,732	10.8
Diabetes-related (250.6)	224,493	87.2
Endocarditis (421)	27,532	10.7
Diseases of the tooth and gum (520–525)	303,568	117.9
Other diagnosis of the jaw, salivary glands, and soft tissue (526–529)	139,767	54.3
Congential anomalies (744, 749, 750.0, 750.1, 750.2, 754.0, 755.55, 756, 765.5, 757.3)	92,901	36.1
Symptoms of the head and neck (784)	1,840,691	714.7
Dysphasia (787.2)	94,091	36.5
Injury (802.0, 802.1, 802.2, 802.3, 830, 848.1, 873.4, 873.5, 873.6, 873.7, 874.4, 874.5)	307,762	119.5
Other (32.1, 101, 230, 270.2, 350.1, 350.2, 697, 710.2, 731, 792.4)	83,244	32.3
All conditions	3,562,488	1,383.3

Table 2. Estimated annual cost of craniofacial conditions by type of cost, in million 1999 dollars

Craniofacial condition	Medical		Wage/household work loss	Total
	Inpatient	Outpatient		
Herpes (053.0, 054.2)	831	11	4,380	5,222
Selected viral-related and chlamydiae (074.3, 078.4, 078.5)	761	1	471	1,233
Candidiasis of the mouth (112.0)	1,644	1	2,291	3,936
Malignant neoplasms (140–149, 195, 196)	2,366	26	7,897	10,289
Benign neoplasms (210, 213, 215, 216)	207	8	791	1,006
Diabetes-related (250.6)	3,117	0.5	8,338	11,455
Endocarditis (421)	1,075	1	262	1,338
Diseases of the tooth and gum (520–525)	2,356	63	3,222	5,641
Other diagnosis of the jaw, salivary glands, and soft tissue (526–529)	925	18	1,697	2,639
Congential anomalies (744, 749, 750.0, 750.1, 750.2, 754.0, 755.55, 756, 765.5, 757.3)	956	14	85	1,055
Symptoms of the head and neck (784)	2,533	461	34,059	37,053
Dysphasia (787.2)	939	2	1,610	2,551
Injury (802.0, 802.1, 802.2, 802.3, 830, 848.1, 873.4, 873.5, 873.6, 873.7, 874.4, 874.5)	2,565	46	8,254	10,866
Other (32.1, 101, 230, 270.2, 350.1, 350.2, 697, 710.2, 731, 792.4)	489	9	1,073	1,572
All conditions	20,765	662	74,430	95,857

Total costs

Annually, 3.6 million cases of craniofacial conditions cause an estimated $95.9 billion in medical and wage/household work costs (Table 2); the sensitivity analysis revealed a range of $82 billion to $101 billion. As Figure 2 shows, 77.6% of the total cost is attributable to wage/household work loss. Four condition groups account for more than 70% of the total costs: symptoms of the head and neck ($37.1 billion), diabetes-related conditions ($11.5 billion), injuries ($10.9 billion), and malignant neoplasms ($10.3 billion).

DISCUSSION

Comparing costs across studies presents many challenges. Hodgson and Cohen show 1995 costs for broad groups of conditions by total personal health care expenditures (hospital care, physician and other professional services, home health care, prescription drugs, medical durables, and nursing home care).[17] For example, the estimated medical cost (hospital care, physician and other professional services, and prescription drugs) in 1995 for diseases of the digestive system (ICD-9-CM codes 520–579) totaled $97.4 billion (in 1999 dollars). We limited our study to selected craniofacial conditions. Estimated annual medical costs for a subset of these systems (520–529), including diseases of the tooth and gum (ICD-9-CM 520–525) and other

Figure 2. Annual costs of all craniofacial-related conditions in million 1999 dollars

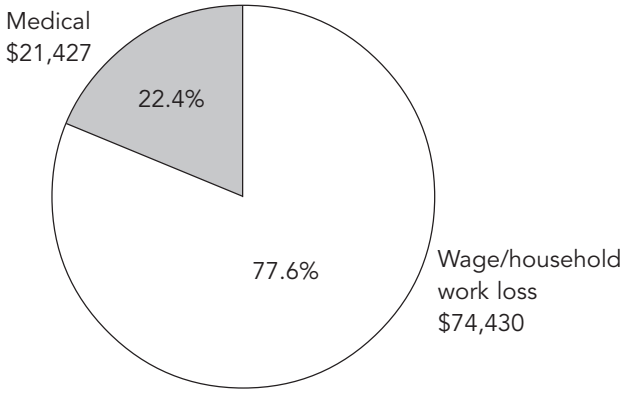

Table 3. Estimated costs per case over one year by craniofacial condition and type of cost, in 1999 dollars

Craniofacial condition	Medical: Cost per inpatient case	Medical: Cost per outpatient case	Medical: Medical cost per case	Wage/household work loss cost per case	Total
Herpes (053.0, 054.2)	14,510	120	5,590	29,080	34,670
Selected viral-related and chlamydiae (074.3, 078.4, 078.5)	35,410	100	25,390	15,720	41,100
Candidiasis of the mouth (112.0)	16,040	100	14,150	19,710	33,860
Malignant neoplasms (140–149, 195, 196)	33,460	480	19,310	63,770	83,080
Benign neoplasms (210, 213, 215, 216)	15,800	530	7,760	28,530	36,290
Diabetes-related (250.6)	14,060	160	13,890	37,140	51,030
Endocarditis (421)	47,380	200	39,100	9,510	48,610
Diseases of the tooth and gum (520–525)	21,480	320	7,970	10,610	18,580
Other diagnosis of the jaw, salivary glands, and soft tissue (526–529)	13,050	260	6,740	12,140	18,880
Congential anomalies (744, 749, 750.0, 750.1, 750.2, 754.0, 755.55, 756, 765.5, 757.3)	24,200	250	10,440	920	11,350
Symptoms of the head and neck (784)	8,340	300	1,630	18,500	20,130
Dysphasia (787.2)	11,210	240	10,010	17,110	27,120
Injury (802.0, 802.1, 802.2, 802.3, 830, 848.1, 873.4, 873.5, 873.6, 873.7, 874.4, 874.5)	12,790	430	8,490	26,820	35,310
Other (32.1, 101, 230, 270.2, 350.1, 350.2, 697, 710.2, 731, 792.4)	12,080	220	5,980	12,890	18,880
All conditions	15,290	300	6,010	20,890	26,910

diagnoses of the jaw, salivary glands, and soft tissue (ICD-9-CM 526–529) were $3.4 million.

Annual spending for dental health services has been estimated at $51.9 billion in 1999 dollars.[18] Craniofacial conditions treated in the medical system add an estimated $21.4 billion to this bill, accounting for close to 30% of the annual oral health care bill.

Limitations of the data systems

The databases used here have been used in several injury cost studies.[12,19–21] All share the same limitations. CHAMPUS covers only small percentages of males ages 18–45 years and individuals ages 65 and older. With the increase in women in the military, however, CHAMPUS coverage of working-age males as military spouses is increasing. In the NHIS, ICD-9-CM codes are generated from the person's self-reported description of the illness or injury, leading to the potential for inaccurate diagnoses. The NHIS sample size is also problematic. Even after samples over the seven-year period were combined, aggregation of several conditions was necessary in order to make stable estimates by diagnosis. NMES data have severe sample size limitations and are not very recent. An obvious limitation of the pooled state data is its potential lack of national representativeness. Despite these limitations, our estimates have an uncertainty range of 25% or less. They provide clear order of magnitude evidence about the importance of craniofacial conditions treated in the medical system.

Conclusions

This article is the first assessment of the costs of medically treated craniofacial conditions. The estimated costs were large, totaling $95.9 billion. Overall, 21.4% of estimated costs were medical costs and 77.6% represented wage/household work losses. Medical costs for these conditions are about 30% ($21.4/$73.3) the size of reported U.S. dental health costs.[18] These conditions often create work losses that endure well be-

yond the time spent in treatment and almost certainly entail larger aggregate work losses than those associated with dental health services. Moreover, while most people receive dental health services each year, medically related craniofacial care is concentrated in less than 1.4% of residents, so the economic impact per person treated is much larger. Understanding, preventing, and treating medically treated craniofacial conditions should be an important focus for the National Institute of Dental and Craniofacial Research.

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