Hospital charges for dental caries related emergency admissions

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Abstract

Purpose: The purpose of this investigation was to develop and test a model for identifying hospital charges resulting from patient admissions through the emergency room of a children's hospital to manage pediatric nontraumatic dental disease.

Method: Model development involved data identification and collection at Children's Medical Center of Dallas, Texas. Its utility was tested in 4 children's hospitals across the United States.

Results: The model proved effective in determining hospital charges for pediatric caries-related admissions. Diagnosis codes assigned at the time of admission were not specific enough to limit identification to nontraumatic dental admissions. Extensive review of patient records determined that only one-third of admitted patients identified by the model were caries-related admissions. Fifty-two children were identified who were admitted to the 5 children's hospitals in 1997 due to dental caries or its complications. Median hospital charge per admission was $3,223 and the total hospital charges for these 52 children was $250,000.

Conclusions: More specific ICD-9 diagnosis codes should be developed to identify these patients. (Pediatr Dent 22:21-25, 2000)

Evidence in the literature supports the fact that the hospital emergency room (ER) is used increasingly to provide medical care for non-emergency type illnesses.[1] Likewise, a trend of increased use of the hospital ER for dental problems which are not related to trauma has appeared in the dental literature. Recent studies report that 40-65% of outpatient ER dental visits were for nontraumatic dental emergencies, and the primary diagnoses were dental caries and abscess due to dental caries.[2-5] A nine-year study at Seattle Children's Hospital and Medical Center ER found that infection-related dental visits increased from 30% in the first four years to 44% in the last four years. Approximately 51% of all patients either had no financial assistance or had Medicaid benefits only.[3]

The appropriateness of the ER setting for management of caries-related disease was evaluated at Seattle Children's Hospital over a three-year period.[6] Only 13% of the 362 patients seen in the ER actually required a hospital setting for treatment. Six patients were admitted, five to receive intravenous antibiotics and one child for an incision and drainage under general anesthesia.

Many of the patients seeking emergency room-based dental care rely on federal or state funded payment programs such as Medicaid.[1,7] A British study evaluating the socioeconomic status of all patients (61,360) admitted to their hospital over a five-year period for dental reasons reported a highly significant correlation between the use of inpatient services (except oral surgery) and social deprivation (P<0.001).[8] This setting is a much more expensive environment than a conventional dental office, and the cost of this care is higher as a result. One study looking at physician fee levels and access to care revealed that children with a doctor's office as a usual source of care had 33% lower total expenses compared to children whose usual source of medical care was a hospital emergency room.[9]

Dental caries, the single most common chronic disease of US children, occurs disproportionately in minority, low-income, and disadvantaged children.[10,11] The National Health and Nutrition Examination Survey (NHANES III) reported that 47% of dental caries in children aged two to nine years remains untreated.[12] Caries also significantly affects the older child. Healthy People 2000 found in 1986 that 54% of children six to eight years old had tooth decay.[13] Despite the goal to reduce caries prevalence to 45%, the Healthy People 2000 1995 interim report on oral health care revealed that childhood caries prevalence had decreased only 2% in nine years.[14] It also showed that untreated caries among six to eight year olds had increased from 27% to 31%.[14] As tooth decay remains untreated, dental problems get progressively worse and ultimately require more expensive interventions, often in a hospital emergency room or operating room.[2,3]

Policy makers would benefit from information concerning charges associated with hospital-based care for dental needs. Interestingly, no studies published have reported these data. In fact, there are no dental models reported for the identification and collection of this type of financial information. Additionally, charges resulting from treatment provided during hospital admission to manage dental-related symptoms may show up as medical charges, disguising the fact that they are dental in origin. Therefore, the purpose of this study was to develop a model for collecting these data in a hospital setting that would be applicable to other children's hospitals across the US. This model was tested in several children's hospitals throughout the US for its ability to provide a mechanism to identify a previously unrecognized expense associated with a preventable dental disease.

Materials and methods

Development of the model occurred at Children's Medical Center (CMC) in Dallas, Texas. CMC is a tertiary-care pedi-

	Dallas N=16	Denver N=11	Ohio N=14	San Antonio N=3	Seattle N=8	All Institutions N=52
Table 1. Days of Hospital Stay Associated with Admissions for Nontraumatic Dental Disease						
Mean	4.1	3.4	4.0	2.7	3.1	3.4
Median	3.5	3.0	3.0	2.5	3.5	3.0
Range	1-13	2-5	2-7	1-5	1-4	1-13
Total	65	37	12	38	25	177

N=Number of admissions.

atric hospital with an emergency room established in 1993, which serves a large metropolitan area. It has a comprehensive dental service that includes a postdoctoral pediatric dentistry teaching program.

The model included the following steps necessary for identification of dental caries related admission charges at Dallas:

Step 1. Hospital permission to obtain confidential patient records: This was given by the Director of Medical Affairs and required submission of the formal study protocol.

Step 2. A computer search based on the International Classification of Disease—Ninth Revision—Clinical Modification (ICD-9 CM) diagnosis codes for dentistry: Each patient is assigned a primary and/or secondary written diagnosis by the admitting physician, which is converted by a hospital staff member into an ICD-9 code.[15] Computer searches using ICD-9 codes of 521.0 (dental caries), 522.5 (periapical abscess without sinus), 522.7 (periapical abscess with sinus), and 682.0 (facial cellulitis) identified 83 patient admissions over the four-year span since the ER opened (1994-97). These codes were designated as primary diagnosis codes for the model.

Step 3. Chart review of the 60 patient records available revealed that only 29 (48%) fit the criteria for caries related dental admissions. The primary diagnosis code of facial cellulitis also diagnosed nasal and/or orbital cellulitis, cheek cellulitis secondary to bites, and cellulitis secondary to previous trauma. Secondary diagnosis codes discovered during the chart review included 520.6 (disturbances in tooth eruption), 528.3 (cellulitis and abscess of oral soft tissue), and 682.1 (neck cellulitis). These codes were designated as secondary diagnosis codes in the model. During the chart review, additional data collected included the reason for admission (diagnosis), ICD-9 primary and secondary diagnosis code, length of stay, treatment rendered, patient age, and payor source.

Step 4. Financial report: Financial information on 27 of the 29 patients was acquired from computer reports through the accounting department.

Finally, all information obtained at Dallas from the computer search, chart review, and computer-based financial record search was compiled. Patient admissions from the 1997 calendar year were separated from the other three years so that these data could be used in comparison with the other institutions that tested the model. A total of 42 patients in 1997 were identified by the ICD-9 computer search, of which 16 patients were dental caries-related admissions at Dallas.

The second purpose of this investigation was to test the model's utility in other institutions for identification of charges related to admissions for nontraumatic dental disease over a period of one year, 1997. Four institutions located throughout the US similar to Dallas agreed to participate: The Children's Hospital of Denver, CO (Denver), Children's Hospital of Columbus, OH (Ohio), Santa Rosa Hospital in San Antonio, TX (San Antonio), and Seattle Children's Hospital and Medical Center in Seattle, WA (Seattle). All institutions were children's hospitals in large metropolitan areas, had a dental service associated with a postdoctoral pediatric dentistry teaching program, and had an emergency room in operation.

Packets were created which included a letter explaining the goals of the study, the model, examples of data collected at Dallas, and forms to be completed on each caries-related dental admission. The formal research proposal was included in case it was needed for obtaining hospital permission. Finally, a questionnaire intended to determine the utility of the model was enclosed. A preposted, self-addressed envelope was enclosed for returning all collected data and the questionnaire. Follow-up telephone calls and electronic mail were made regularly to determine the status of the investigation as each step of the model was followed.

Results

Model testing in the four recruited institutions produced mixed results. The computer searches using the four designated ICD-9 primary diagnosis codes yielded 128 patients from the four institutions. Two additional primary diagnosis codes were necessary at Ohio: 526.0 (developmental odontogenic cyst),
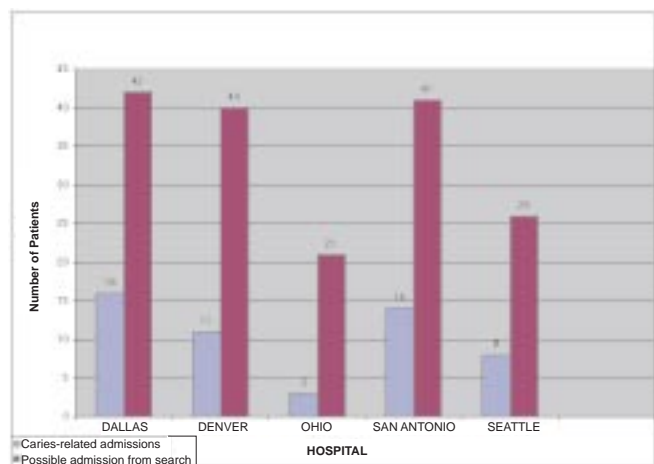

Fig 1. A comparison of possible admissions identified by the computer search with caries-related admissions identified by the chart review at each institution in 1997.

Table 2. Hospital Charges Associated with Admissions for Nontraumatic Dental Disease					
	Dallas N=**16**	**Denver** N=**11**	**Ohio** N=**3**	**San Antonio** N=**14**	**Seattle** N=**8**	**All Institutions** N=**52**
Mean	$7,946	$3,790	$12,056	$3,056	$3,795	$5,196
Median	$3,223	$3,430	$5,229	$2,276	$4,209	$3,223
Range	$1,784-$42,345	$1,451-$7,273	$2,647-$28,293	$460-$7,142	$866-$4,896	$406-$42,345
Total	$119,195	$41,694	$36,169	$42,787	$30,357	$270,202

N=Number of admissions.

and 527.2 (sialoadenitis). Additional secondary diagnosis codes which were identified included 528.3 (cellulitis and abscess of oral soft tissues), 376.01 (orbital cellulitis), 528.3, 525.8 (other specified disorders of teeth and supporting structures), and 784.2 (head or neck swelling).

Only 36 of the 128 patients were confirmed through time-consuming chart review as actual admissions for nontraumatic dental disease, casting doubt on the adequacy of the ICD-9 codes for accurate identification. Other reasons for admission with the ICD-9 diagnosis code 682.0 (facial cellulitis) included non-dental origin, dog and insect bites, post-operative bacterial infections, eye infections, and postoperative wound infections. These data are summarized by institution in Fig 1.

Data collected about hospital charges, numbers of hospital days, patient age, and payor source for admitted patients through use of the model by the four institutions were combined with data collected at Dallas for purposes of reporting. Total caries-related admissions for all five institutions for 1997 were 52 and ranged from a high of 16 at Dallas to a low of three at Ohio (Fig 1).

Table 1 summarizes information about numbers of hospital days associated with admissions for the five institutions. Total hospital days for the 52 admissions were 177 and ranged from 1-13 days. The average stay was 3.4 days and the median stay was 3 days. The longest stay was 13 days in Dallas for Lugwigs angina.

All institutions were able to locate charges associated with the dental admissions using the model as described. Table 2 summarizes hospital charges associated with admissions at each of the five institutions. The total hospital charges for all 52 patient admissions were $270,202 and ranged from a high of $119,195 at Dallas for 16 admissions to a low of $30,357 at Seattle for eight patient admissions. The average cost ranged from a low of $3,056 at San Antonio to a high of $12,056 at Ohio. Charges per single admission ranged from a high of $42,345 at Dallas to a low of $460 at San Antonio. Three admissions were much higher than the other 49: two at Dallas ($42,345 for a 13-day admission due to the development of Ludwig's angina and $23,555 for six days due to hematemesis) and the third at Ohio ($28,293). Charges for one-day admissions ranged from a low of $406 to a high of $2,830, both at San Antonio.

Most patients admitted were from low-income families. The payor sources for the 52 patients admitted in the five institutions were: 8 insurance, 30 Medicaid, 8 self-pay, and 6 undetermined. A comparison of payor sources for each institution is shown in Figure 2. Ages of patients admitted at the testing institutions ranged from 21 months to 17 years, 5 months, with an average age of 7 years.

All institutions completed the questionnaire concerning the utility of the model and responses indicated that they felt the model functioned and was easy to use. Ohio recommended cross-referencing the ICD-9 codes with specific services in the hospital. The average amount of time required for data collection was 4.5 hours. Only two of the four institutions required an expedited Institutional Review Board approval with a copy of the formal proposal for obtaining permission to view confidential patient information. At all institutions admitting physicians made a written diagnosis, while a hospital staff member entered the corresponding ICD-9 diagnosis code.

Discussion

This investigation intended to create and test a model to identify hospital charges associated with admissions for dental caries related sequelae. As more emphasis is placed on collecting data related to patient treatment and outcomes measurements, such models will become increasingly important. These models must be efficient and accurate. The model developed and tested in this investigation was eventually accurate but not efficient, due to several issues which require discussion.

The first is the inadequacy of existing ICD-9 codes for use in dentistry. Use of these codes was critical for data identification, and no previous studies had mentioned the need for using ICD-9 diagnosis codes for identifying charges related to dental diagnoses in a hospital. A study published in the *British Journal of Oral and Maxillofacial Surgery* discussed the importance of using "procedure codes to cost inpatient activity."[8] These British procedure codes are similar to the US ICD-9 diagnosis and procedure codes. Initially, four common diagnosis codes—521.0 (dental caries), 522.5 (periapical abscess without sinus), 522.7 (periapical abscess with sinus),
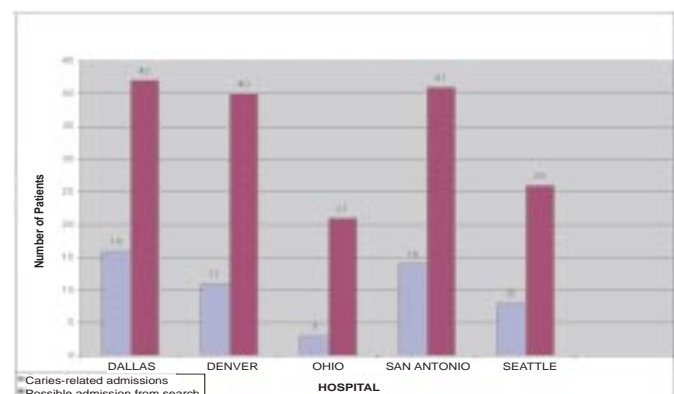

Fig 2. A comparison of payor sources per patient admission at each institution in 1997.

and 682.0 (facial cellulitis) were found to be used for patients admitted through the emergency room due to dental disease. However, model testing identified seven additional codes which were used as both primary and secondary diagnosis codes.

Identification of the appropriate ICD-9 codes did not lead to efficient or accurate collection of the data. Nearly two-thirds of the patients identified by these codes did not fit the criteria for being a nontraumatic dental admission. A thorough chart review that consumed approximately five hours at each institution was necessary to identify those admissions which fit the study criteria. The four primary codes initially designated in the model were specific enough to identify 52 nontraumatic dental admissions, yet not specific enough to exclude 159 non-dental admissions for conditions such as facial cellulitis resulting from dog bites. More specific ICD-9 diagnosis codes concerning dental problems are needed.

Diagnosis codes for medical conditions are developed with numbers to the right of the decimal point to allow sub-diagnoses of a general diagnosis. For example, code 282 speci-fies hereditary hemolytic anemias. More specific anemias such as thalassemia (282.4) and sickle cell anemia (282.6) are assigned numbers in the tenth decimal point. Additionally, these can be further subcategorized into more specific diagnoses using the hundredth decimal point. For example, code 282.61 identifies sickle cell anemia without mention of crisis.[15] This use of decimal points allows for a great deal of specificity in diagnosis.

Dental diseases generally do not have such specific ICD-9 diagnosis codes available. Diagnosis codes from 520.0 to 529.0 are identified as diseases of the oral cavity, salivary glands, and jaws.[15] Even subdiagnosis codes are limited in number and too broad to identify many specific conditions. For example, code 520.2 is a diagnosis for abnormalities of size and form in dis-orders of tooth development and eruption.[15] Numerous developmental dental problems are included under this diagnosis, including fusion, gemination, microdontia, macrodontia, peg-shaped teeth, and taurodontism. The abil-ity to be more specific in assigning dental diagnoses would have facilitated the computer search in this model and narrowed the number of patients identified and reduced the numbers of lengthy chart reviews required. The effectiveness of the model would also be less dependent upon the availability of the medical record to confirm accuracy of patient identification.

Additionally, determining which ICD-9 diagnosis codes admitting emergency room physicians and staff use for caries-related dental admissions was just as important to the eventual success of the model. The necessity of training both physicians and staff members in the use of ICD-9 diagnosis codes for diagnosing dental emergencies became apparent in this investigation. Interviews with emergency medicine residents at Dallas revealed that the only formal dental training they had received was in medical school.[16] Since this training was not comprehensive, most residents did not feel comfortable distinguishing between a primary and permanent tooth, and were even more uncomfortable when dental emergencies presented to the emergency room.[16]

Retrieval of the financial information for the admitted patients that fit the criteria was the least problematic step in the investigation for all institutions. Total hospital charges were over $250,000 for the 52 admitted patients, and with the exception of three very expensive admissions, two at Dallas

($42,345 and $23,555) and one at Ohio ($28,293), the average charges were fairly uniform among reporting nstitutions and averaged between $3,000 and $4,000. Removal of the three charges from the data for Dallas and Ohio and recalculation of the average charges places these two institu-tions within the range reported for the other institutions. The single most expensive admission of $42,345 for a 13-day admission due to the development of Ludwig's angina was a significant expense for the sequelae to a disease that is entirely preventable with early and regular dental visits.

The numbers of admissions varied broadly, from a low of 3 at Ohio to a high of 16 at Dallas. Limiting the recruited institutions to those with associated pediatric dentistry teaching programs was intended to insure that all institutions would have equal access to dentists present in the ER. However, no information was requested about whether dental consultations were sought in the decisions to admit patients for management of dental caries-related sequelae. Future studies need to evaluate this parameter. It is possible that the institutions with higher rates of admission had less well-established mechanisms for dental consultations prior to patient admissions.

The finding in this study that the majority of patients admitted had Medicaid benefits or no payor source is in agreement with those findings reported by Seattle Children's Hospital and Medical Center that approximately 51% of all patients either had no financial assistance or had Medicaid benefits only. The hospital absorbs the charges associated with bad debt. The average age of seven years for patients admitted at the testing institutions were in agreement with those reported by previous investigators[2-5] and was a surprise, as it was expected that the sequelae to early childhood caries would be a larger contributor to use of the ER for nontraumatic dental disease.

Future use of this model would benefit from the development of more specific ICD-9 diagnosis codes for dentistry and better training of emergency room physicians and staff in the use of these dental codes. This study did not intend to determine if definitive treatment was obtained for the offending tooth/teeth that caused the admission of each patient. Future studies are needed to evaluate this aspect of patient care. Additionally, this study did not intend to determine the appropriateness of each patient admission. It is possible that some of these children may have been well-managed with extractions and/or oral antibiotics without admission to the hospital. The motive of the emergency room physician for admission of these patients was not determined. The subjective opinion of that physician for the potential for complete compliance with treatment of the offending tooth/teeth by the child's family may have contributed to the reason for the admission. Outpatient emergency treatment and/or referral to a local dentist would have significantly reduced these hospital charges incurred from preventable dental disease.

The goal of the development of the model was the collection of financial information associated with hospital admissions for complications secondary to dental caries. The charges sought were expected to be medical charges, since most of the billable items related to a hospital admission concerned "medical management" of the sequelae to untreated dental disease, such as cellulitis, infection, fever, or dehydration. This is a very expensive outcome to a disease that can be managed easily and inexpensively through preventive efforts. These

dollars could be saved if treatment of dental disease occurred before it became a potentially life-threatening condition, as in the case of Ludwig's angina.

Conclusions

1. This model, created at Dallas, is applicable and usable in similar children's hospitals, but is not efficient, as only 30% of the admissions identified were actual dental caries-related admissions.
2. ICD-9 diagnosis codes are inadequate for diagnosis of specific dental problems, especially concerning caries-related patient admissions.
3. Use of the model required a time-consuming chart review to eliminate two-thirds of patients identified by the computer search who are not caries-related patient admissions.
4. Emergency room personnel training in the correct identification and diagnosis of dental disease would contribute to the efficiency of the model.
5. The median charge per in-patient admissions in 1997 in five hospitals across the US for nontraumatic dental disease was $3,223, and the total charges for all 52 admissions were $270,202.

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ABSTRACT OF THE SCIENTIFIC LITERATURE

FERMENTABLE SUGARS AND METABOLIC ACIDS THAT BECOME TRAPPED ON THE DENTITION

This study was undertaken to measure sugars, starches and metabolic acids in retained food particles. Study subjects consumed portions of different foods, then particles were removed from all bicuspids and first molars at defined times after swallowing. Dry weights and levels of sugars and short-chain carboxylic acids were determined. The study demonstrated the persistence of sugars, the progressive accumulation of starch breakdown products and the fermentation of the accumulated sugars in retained foods particles. The findings support the view that high-starch foods contribute to the development of caries lesions. The critical difference between high-starch foods and high-sucrose confections was that the latter delivered high levels of sugars to local bacteria immediately after ingestion, but for short periods of time, while the former delivered progressively increasing concentrations of sugars over a considerably longer time

Comments: To date, this is the definitive study on the role of high-starch foods in caries development. It clearly demonstrates that potato chips, salted crackers and other high-starch low-sucrose foods can exhibit relatively high cariogenic potential. In addition, it further underscores the difficulty in making food comparisons in the context of caries-causing potential. Advising the reduction or elimination of sugar from a child's diet in the prevention of caries may be ineffectual at best, nutritionally confounding at worst. **SJM**

Accumulation of Fermentable Sugars and Metabolic Acids in Food Particles that Become Trapped on the Dentition. Kashket S, Zhang J, Van Houte J. J Dent Res. 1996 Nov;75(11):1885-91.
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