Oral Disease Burden and Utilization of Dental Care Patterns Among Pediatric Solid Organ Transplant Recipients

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Abstract

Objectives: *We conducted a study among pediatric renal (RTRs) and liver transplant recipients (LTRs) to determine: a) the overall burden of oral disease; and b) the frequency with which this population utilizes dental care services in relation to sociodemographic factors and oral disease burden.* ***Methods:*** *In this cross-sectional survey, study procedures included the completion of a standardized questionnaire (by parents/guardians), oral mucosal examination, assessment of caries, gingival enlargement, and plaque index.* ***Results:*** *The 142 children (82 RTRs and 60 LTRs) enrolled from April 2002 to November 2005 were predominantly Latino (41 percent) and Caucasian (34 percent). Forty-three percent had at least one carious surface (in either a deciduous or permanent tooth), 19 percent had five or more carious surfaces, and 25 percent had gingival enlargement. We found only one case of oral candidiasis. Even though 72 percent of parents/guardians reported their child had a regular source of dental care, only 49 percent had a dental cleaning and 44 percent had dental radiographs in the past year, reflecting a low prevalence of preventive dental care. Among children with no regular source of dental care, there were statistically significantly higher proportions of Latinos, younger children, and families with an annual household income <$35,000.* ***Conclusion:*** *While the prevalence of oral mucosal disease and gingival enlargement was low, the prevalence of children with caries was high, and there was low use of preventive dental care. Strategies to improve this population's utilization of preventive dental care are needed.*

Key Words: organ transplantation, pediatric dentistry, caries, dental care utilization

Introduction

The outcomes of solid organ transplantation have improved steadily since the early 1980s following the introduction of cyclosporine-based immunosuppression. In 2006, children accounted for 5.2 and 8.7 percent of the 17,090 kidney and 6,650 liver transplants, respectively, performed in the United States (1). Organ transplant recipients (OTRs) are maintained in a state of immunosuppression to prevent graft rejection, and these drug regimens may have adverse effects on the oral cavity. Opportunistic pathogens may cause oral mucosal lesions (2,3), and gingival enlargement may result from drug regimens that include cyclosporine and calcium channel blockers (4-9). Because most of these children are medically compromised at the time of transplantation, dental decay, dental infections, or prematurely missing teeth often associated with inadequate nutrition may further jeopardize their general health while they receive immunosuppressive medications. Regular preventive dental care is thus essential for pediatric OTR, but little is known about the pattern of dental care utilization in this patient population in the United States. We therefore conducted a novel study among pediatric renal (RTRs) and liver transplant recipients (LTRs) to determine the overall burden of oral disease and the frequency with which this population utilizes dental care services. We also explored the utilization of dental care in relation to several potential explanatory variables, both sociodemographic factors and oral disease burden in this population.

Methods

Study Design and Population. We conducted a cross-sectional survey of pediatric RTRs and LTRs recruited from the outpatient Kidney Transplant Unit and Liver Transplant Unit at the Children's Hospital of the University of California San Francisco (UCSF). Participants were less than 18 years of age, at least 6 months post-transplant, and were recruited using a consecutive sampling strategy. The study had received approval from the Committee on Human Research. Patients were recruited, as they

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presented for one of their follow-up visits at their respective clinic, by a research assistant who explained the study objectives and obtained written informed consent from the parents and assent from the children.

Variables and Measures. Study procedures included the completion of a questionnaire (by the participants' parents/guardians), an oral mucosal examination, a dental examination, and the assessment of gingival enlargement as follows.

Questionnaire data. A questionnaire was designed to collect information on sociodemographic characteristics, and oral and general health history, and to assess the frequency of, and factors associated with, utilization of dental care services over the 1-year period preceding the study visit. We extracted the majority of questionnaire items from two previous surveys of utilization of dental care we conducted among other immunosuppressed populations (10,11). For these surveys, we had adapted measures of dental care utilization from the 1989 National Health Interview Survey (12) and the 1975-1976 US population household survey by the Center for Health Administrative Studies (13).

Clinical data. Oral examinations were performed by three residents in the UCSF Pediatric Dentistry residency program who had received training in the diagnosis of specific oral mucosal conditions commonly seen in immunosuppressed populations (mainly candidiasis, hairy leukoplakia, aphthous-like ulcers, herpes simplex ulcers, and warts). They were calibrated in the use of the various indices selected for this study as follows: the *decayed–missing–filled surfaces* index (DMFS for permanent teeth and defs for deciduous dentition) (14) was used to assess the prevalence of dental caries.

The plaque index developed by Silness and Löe was measured on all teeth (one buccal and one lingual site) as an objective measure of oral hygiene (15). Gingival enlargement was measured using the Aas index (16). We decided to use a visual index instead of an approach based on alginate impressions to avoid overburdening study participants whose age ranged from 1 to 17 years. In this index, the mouth is divided in sextants, and each sextant is graded according to the most severe site.

- Grade 0: No gingival enlargement. The gingiva follows a normal contour on all teeth.
- Grade 1: Slight or moderate gingival enlargement. The interdental papillae have assumed a more rounded blunt form; the gingival margin is slightly thickened. The anatomical crowns are covered up to one-third of the vestibular surfaces.
- Grade 2: Marked gingival enlargement. The papillae and the gingival margin cover from one-third to one-half of the vestibular surfaces. In most cases, the papillae are separated only by a V-shaped cleft.
- Grade 3: Severe gingival enlargement. The gingiva propria covers one-half to two-thirds of the vestibular surfaces and protrudes 3-4 mm from the surface of the teeth.
- Grade 4: Very severe gingival enlargement. The hyperplastic tissue covers from two-thirds to the whole of the anatomical crowns in one or more regions, and occlusion is rendered difficult, if not prevented.

We collected 5 mL of whole unstimulated saliva by asking participants who were old enough to comply to spit into a graduated 50 mL tube. The saliva was cultured within 2 hours for the presence of *Candida* expressed as colony-forming units per milliliter of saliva.

Utilization of dental care model. We used the behavioral model, developed by Andersen, in which utilization of health care services over a given period of time is explored in relation to predisposing, enabling, and need (PEN) variables (17-19). We measured two outcomes to reflect utilization of care: a) whether or not a child had a regular source of dental care; and b) whether or not a child had visited the dentist in the past year. With respect to the independent variables explored, the predisposing factors (which reflect the propensity of an individual, or his/her parents/guardians, to seek care) measured in this survey included race, age, gender, and mother and father's education. The enabling variables we considered were family's annual income, family size, and dental insurance status. We assessed the need from the presence of untreated caries, whether or not the child had gingival enlargement, presence of oral mucosal disease, and the parent/guardian's perception of the child's oral health. We expanded Andersen's model by also including variables pertaining to the children's history of transplantation: the type of transplant (kidney or liver) and the history of acute graft rejection.

Statistical Analysis. We computed the kappa statistic to compare each of the three examiners to one examiner used as gold standard with respect to the DMFS index (sound versus carious surfaces) measured on 140 surfaces for each examiner, and to the gingival enlargement index measured on six sites for each examiner. We also compared each examiner against the other two with respect to 280 sites for the DMFS index, and 12 sites for the gingival enlargement index.

We used proportions to summarize sample characteristics, oral diseases (dental caries, gingival enlargement, and oral mucosal disease), and frequency of use of dental care services. We performed univariate analyses using contingency table methods and chi-square statistics or Fisher's exact tests to compare these characteristics by transplant type, and to explore the association between PEN variables and: a) whether or not a child had a regular source of dental care; and b) utilization of dental care services in the past year. To further explore these outcomes while controlling for potential confounders, we fit logistic regression models including

independent variables among the PEN characteristics that were associated with either outcome at the 0.1 level of significance or that were thought to be confounders.

Results

Sociodemographic Characteristics. We enrolled a total of 142 children (82 RTRs and 60 LTRs) from April 2002 to November 2005. The sample included a female/male ratio of 1/1.5, a predominance of Latinos (41 percent) and Caucasians (34 percent; Table 1). Nearly 80 percent were over the age of 5 years. The education level of both mothers and fathers was fairly evenly distributed, ranging from not having graduated from high school (23 and 18 percent, respectively) to having graduated from college (24 percent in either group; Table 2). The majority of children lived in households of four or more members (73 percent), with an annual income below $35,000 (52 percent). There were equal proportions of children with private dental insurance (42 percent) or with some form of state-funded insurance (DentiCal, California Child Services, or Healthy Children; 42 percent), and 14 percent had no coverage. RTR and LTR did not differ with respect to any sociodemographic variables except for age, with a significantly higher proportion of RTR over the age of 9 years.

Inter-Examiner Calibration. The kappa statistic comparing the DMFS measured by each examiner to the DMFS measured by an examiner used as a gold standard on 140 sites yielded scores of 0.87, 0.78, and 0.90, respectively. The kappa score for the DMFS measured on 280 sites was 0.79 when comparing examiners 1 and 2, 0.73 when comparing examiners 2 and 3, and 0.78 when comparing examiners 1 and 3. For the gingival enlargement index, there was perfect concordance between each examiner and the gold standard with a kappa of 1. The kappa was 0.99 when comparing examiners 1 and 2, and examiners 1 and 3, and it was 1.0 when comparing examiners 2 and 3.

Table 1
Demographic Characteristics of Pediatric Renal (RTRs) and Liver Transplant Recipients (LTRs)

Characteristic	All participants* (*N* = 142) *n* (%)	RTRs* (*N* = 82) *n* (%)	LTRs* (*N* = 60) *n* (%)	*P* value†
Gender				
Male	85 (60)	52 (63)	33 (55)	
Female	57 (40)	30 (37)	27 (45)	0.4
Race/ethnicity				
Latino	58 (41)	39 (48)	19 (33)	
Caucasian	48 (34)	26 (32)	22 (38)	
Asian	20 (14)	10 (12)	10 (17)	
African American	7 (5)	3 (4)	4 (7)	
Other	7 (5)	4 (5)	3 (5)	0.4
Age (years)				
<3	8 (6)	2 (2)	6 (10)	
3-5	22 (16)	8 (10)	14 (23)	
6-9	29 (20)	11 (13)	17 (28)	
≥10	84 (59)	61 (74)	23 (38)	<0.001

* Column count for each characteristic may not add up to total column count because of missing values. Column percent may not add to 100 because of rounding.
† *P* value for two-sided Fisher's exact test of association with transplant type (RTR versus LTR).

Table 2
Socioeconomic Characteristics of Pediatric Renal (RTRs) and Liver Transplant Recipients (LTRs)

Characteristic	All participants* (*N* = 142) *n* (%)	RTRs* (*N* = 82) *n* (%)	LTRs* (*N* = 60) *n* (%)	*P* value†
Mother's education				
High school not completed	29 (23)	18 (24)	11 (20)	
High school graduate	34 (26)	19 (25)	15 (28)	
Some college education	35 (27)	22 (29)	13 (24)	
College graduate	31 (24)	16 (21)	15 (28)	0.8
Father's education				
High school not completed	21 (18)	13 (18)	8 (17)	
High school graduate	36 (31)	23 (32)	13 (28)	
Some college education	32 (27)	19 (27)	13 (28)	
College graduate	28 (24)	16 (23)	12 (26)	0.9
Family size (number of persons living in household)				
Two	9 (6)	5 (6)	4 (7)	
Three	29 (21)	17 (21)	12 (20)	
Four	50 (36)	24 (30)	26 (44)	
Five	27 (19)	21 (26)	6 (10)	
Six or more	25 (18)	14 (17)	11 (19)	0.4
Household annual income ($)				
<15,000	42 (33)	27 (38)	15 (27)	
15,000-34,999	24 (19)	15 (21)	9 (16)	
35,000-49,999	15 (12)	9 (13)	6 (11)	
50,000 or more	46 (36)	21 (29)	25 (45)	0.3
Dental insurance coverage				
Private/Other	59 (42)	34 (41)	25 (42)	
State assistance	60 (42)	36 (44)	24 (40)	
None	20 (14)	11 (13)	9 (15)	0.9

* Column count for each characteristic may not add up to total column count because of missing values. Column percent may not add to 100 because of rounding.
† *P* value for two-sided Fisher's exact test of association with transplant type (RTR versus LTR).

Transplant-Related History and Oral Disease Burden. The majority of children had received a transplant from a deceased donor (60 percent), and the proportion of children who received a transplant from a living-related donor was higher among RTRs than among LTRs (50 versus 23 percent; $P = 0.002$; Table 3). Also, the proportion of children who had received their transplant more than 2 years prior to the study was higher among the LTRs (73 percent) than among the RTRs (45 percent). One-third of the children in either group had experienced acute graft rejection at some point, and 89 percent had received only one graft. Immunosuppressive regimen differed according to the type of transplant as 95 percent of the RTRs were receiving a combination of immunosuppressive medications, while 72 percent of the LTRs were receiving only one agent. Among the RTRs, 98 percent were receiving low-dose prednisone (versus 13 percent among the LTRs), 59 percent were receiving mycophenolate mofetil (versus 23 percent among the LTRs), 63 percent were receiving tacrolimus (versus 66 percent among the LTRs), and 26 percent were on cyclosporine (versus 30 percent among the LTRs). A small percent of RTRs (10 percent) and LTRs (3 percent) were receiving sirolimus. Only one LTR was receiving an antihypertensive medication versus 68 percent of RTRs. Overall, 27 percent were taking an antifungal, 87 percent of which was fluconazole.

Over one-third of the children had a combined defs–DMFS score ≥5; 43 percent had at least one untreated carious tooth surface, and 19 percent had five or more untreated carious surfaces (Table 3). The median defs–DMFS score was 4 [ranging from 0 to 40; 95 percent confidence interval (CI): 1; 8] among the LTRs, and 1 (ranging from 0 to 46; 95 percent CI: 0; 2) among the RTRs, a difference that was statistically significant using a rank sum test (Mann–Whitney; $P = 0.05$). One-quarter of the children were found to have at least one sextant with gingi-

Table 3
Transplant-Related History and Oral Disease Burden of Pediatric Renal (RTRs) and Liver Transplant Recipients (LTRs)

Characteristic	All participants* ($N = 142$) *n* (%)	RTRs* ($N = 82$) *n* (%)	LTRs* ($N = 60$) *n* (%)	*P* value†
Transplant source				
Deceased donor	81 (60)	39 (49)	42 (75)	
Living – related	53 (39)	40 (50)	13 (23)	
Living – unrelated	2 (1)	1 (1)	1 (1)	0.002
Time since transplant (year)				
≤1	43 (34)	34 (45)	9 (18)	
>1; ≤2	13 (10)	8 (11)	5 (10)	
>2	71 (56)	34 (45)	37 (73)	0.004
History of acute rejection				
Yes	42 (33)	24 (32)	18 (33)	
No	87 (67)	51 (68)	36 (67)	1.0
defs–DMFS‡				
0	56 (41)	35 (43)	21 (37)	
1-4	34 (25)	24 (30)	10 (18)	
5-8	15 (11)	9 (11)	6 (11)	
≥9	33 (24)	13 (16)	20 (35)	0.07¶
Untreated caries				
0	80 (58)	50 (61)	30 (53)	
1-4	33 (24)	20 (24)	13 (23)	
5-8	10 (7)	4 (5)	6 (11)	
≥9	16 (12)	8 (10)	8 (14)	0.5
Gingival enlargement				
Present	34 (25)	22 (28)	12 (21)	
Absent	102 (75)	58 (72)	44 (79)	0.5
Gingival enlargement grade§				
0	102 (75)	58 (73)	44 (79)	
1	19 (14)	12 (15)	7 (13)	
2	10 (7)	7 (9)	3 (5)	
3	1 (<1)	0	1 (2)	
4	4 (3)	3 (4)	1 (2)	0.7
Oral mucosal lesions				
None	132 (94)	78 (95)	54 (93)	
Any oral lesion	8 (6)	4 (50)	4 (7)	0.7
Oral candidiasis	1 (<1)	1 (1)	0	
Aphthous ulcer	1 (<1)	1 (1)	0	
Other	6 (4)	2 (2)	4 (7)	
Parent perception of child's oral health				
Excellent/very good	32 (23)	20 (25)	12 (20)	
Good	50 (36)	25 (31)	25 (42)	
Fair	45 (32)	25 (31)	20 (33)	
Poor	14 (10)	11 (14)	3 (5)	0.5

* Column count for each characteristic may not add up to total column count because of missing values. Column percent may not add to 100 because of rounding.

† *P* value for two-sided Fisher's exact test of association by transplant type (RTR versus LTR).

‡ defs in deciduous dentition and DMFS in permanent dentition were combined as a majority of children had mixed dentition.

¶ A nonparametric rank sum test (Mann–Whitney) comparing DMFS–defs in RTR and LTR yielded $P = 0.05$.

§ Gingival enlargement grade defined by the sextant with the most severe grade using the Aas visual index.

val enlargement grade 1, and 11 percent had at least one sextant with gingival enlargement grade 2 or higher. Only one child in the entire group had clinical signs of candidiasis. However, 10 children among the 121 participants who had a saliva sample collected were found to have *Candida* present in saliva between 500 and 3,320 CFU/mL. Overall, 42 percent of parents reported a perception of their child's oral health as being only fair or poor.

Patterns of and Barriers to Dental Care Utilization. The parents/guardians of 72 percent of the participants reported that their child had a regular source of dental care (Table 4), and this proportion was similar in both groups. A large majority (81 percent) had seen a dentist in the past year; however, less than 50 percent had received a dental cleaning and less than 45 percent had dental radiographs. When exploring whether or not participants had a regular source of dental care in relation to PEN variables, we found significant associations with a number of variables in univariate analyses. Among predisposing variables, race was associated with having a regular source of dental care, with 57 percent of Latinos versus 26 percent of Caucasians among those who did not have a source of regular care ($P = 0.05$; Table 5). Not surprisingly, the proportion of younger participants was significantly higher among non-regular users. With respect to enabling variables, the proportion of children whose family's household income was below $35,000/year was significantly higher among the non-regular dental users. However, dental insurance was not found to be associated with regular use of dental care. More than half of the children who had no regular source of dental care had one or more untreated caries, with 23 percent having nine or more, compared to 9 percent among regular users. We found a median of 0 carious surface (range: 0-18) among regular users compared to one surface (range: 0-61) among non-regular users (Mann–Whitney rank sum test; $P = 0.05$). Other oral diseases such as gingival enlargement were not found to be associated with regular use of dental care, nor were the transplant type. The proportion of children whose parents perceived their child's oral health as being fair to poor was significantly higher among the non-regular users. We also explored the outcome "any use of dental care in the past year versus no past year use" in relation to the same independent variables listed in Table 5. However, this outcome was not associated with any of these variables.

Because the univariate analyses revealed significant associations only for the outcome "regular source of dental care versus none," our multivariate analysis focused on that outcome only. A logistic regression model revealed that participants 6 years or older were 6.8 times more likely to have a regular source of dental care than younger children (95 percent CI: 1.9; 25; $P = 0.004$). Children who lived in a household with an annual income <$15,000 had an adjusted odds ratio of having a regular source of dental care of 0.1 (95 percent CI: 0.03; 0.6; $P = 0.01$) compared to those from a household with ≥$35,000 in annual income. We found no association between regular source of dental care and race, mother's education, perceived oral health of either child or parent, and untreated caries at the multivariate level.

As a measure of unmet dental need, we asked the parents/guardians if they felt their child had needed to see a dentist in the past year, but had not for some reason. Among the 134 parents who responded to this question, 55 (41 percent) responded yes. We asked about specific reasons why they felt their child had not received dental care when needed to explore potential barriers to dental care. The most common responses were "they could not find a dentist familiar with dental care among solid organ transplant patients" (40 percent), and "they thought the condition was not serious enough" (22 percent). Eighteen percent said they did not know what dentist to go to.

Table 4
Pattern of Utilization of Dental Care Services Among Pediatric Renal (RTRs) and Liver Transplant Recipients (LTRs)

Characteristic	All participants* ($N = 142$) *n* (%)	RTRs* ($N = 82$) *n* (%)	LTRs* ($N = 60$) *n* (%)	*P* value†
Reports source of regular dental care				
Yes	94 (72)	53 (75)	41 (68)	
No	37 (28)	18 (25)	19 (32)	0.4
Any dental care in past year				
Yes	114 (81)	69 (86)	45 (75)	
No	26 (19)	11 (14)	15 (25)	0.1
Dental cleaning in past year				
Yes	68 (49)	36 (45)	32 (53)	
No	72 (51)	44 (55)	28 (47)	0.6
Dental radiographs in past year				
Yes	62 (44)	33 (41)	29 (48)	
No	78 (56)	47 (59)	31 (52)	0.7
Time since last dental visit				
<6 months	93 (66)	59 (74)	34 (57)	
6-12 months	21 (15)	10 (13)	11 (18)	
>1 year; <2 years	13 (9)	6 (8)	7 (12)	
2 years or more	6 (4)	3 (4)	3 (5)	
Never visited dentist	7 (5)	2 (3)	5 (9)	0.2

* Column count for each characteristic may not add up to total column count because of missing values. Column percent may not add to 100 because of rounding.

† *P* value for two-sided Fisher's exact test of association by transplant type (RTR versus LTR).

Table 5
Regular Use of Dental Care Services by Predisposing, Enabling, and Need (PEN) Variables Among Pediatric Renal (RTRs) and Liver Transplant Recipients (LTRs)

PEN variables	Regular source of dental care: Yes* (*N* = 94) *n* (%)	Regular source of dental care: No* (*N* = 37) *n* (%)	*P* value†
Predisposing variables			
Gender			
Male	57 (61)	23 (62)	
Female	37 (39)	14 (38)	1.0
Race/ethnicity			
Latino	30 (32)	20 (57)	
Caucasian	38 (40)	9 (26)	
Asian	15 (16)	5 (14)	
Other	11 (12)	1 (3)	0.05
Age (years)			
<3	2 (2)	6 (16)	
3-5	14 (15)	7 (19)	
6-9	20 (21)	7 (19)	
≥10	58 (62)	17 (46)	0.03
Mother's education			
High school not completed	16 (19)	10 (30)	
High school graduate	24 (28)	9 (27)	
Some college education	21 (24)	10 (30)	
College graduate	25 (29)	4 (14)	0.07
Enabling variables			
Household annual income ($)			
<15,000	21 (24)	17 (55)	
15,000-34,999	18 (21)	5 (16)	
35,000 or more	47 (55)	9 (29)	0.003
Dental insurance coverage			
Private/other	43 (46)	12 (33)	
State assistance	36 (38)	18 (19)	
None	14 (15)	6 (17)	0.4
Need variables (oral health and transplant related)			
Untreated caries			
0	55 (60)	16 (46)	
1-4	24 (26)	8 (23)	
5-8	5 (5)	3 (9)	
≥9	8 (9)	8 (23)	0.06
Gingival enlargement			
Present	21 (23)	10 (29)	
Absent	70 (77)	24 (71)	0.5
Parent perception of child's oral health			
Excellent/very good	26 (28)	4 (11)	
Good	38 (40)	11 (30)	
Fair	26 (28)	16 (43)	
Poor	4 (4)	6 (16)	0.01
Transplant type			
RTR	53 (56)	18 (49)	
LTR	41 (44)	19 (51)	0.4

* Column count for each characteristic may not add up to total column count because of missing values. Column percent may not add to 100 because of rounding.
† *P* value for two-sided Fisher's exact test of association by regular use of dental care.

Discussion

This is the first study to describe the extent of oral disease (including oral mucosal disease, dental caries, and gingival enlargement) and to explore the patterns of dental care utilization in a large sample of pediatric RTRs and LTRs. Furthermore, this is an ethnically diverse sample consisting predominantly of Latinos, Caucasians, and Asians, and with a fairly even distribution of variables reflecting socioeconomic status. This group was found to have a high prevalence of dental disease with 43 percent having at least one carious surface (in either a deciduous or permanent tooth) and 19 percent with five or more carious surfaces. One-quarter of the patients had some form of gingival enlargement, but less than 5 percent had a severe grade. With respect to oral mucosal lesions, we found only one case of oral candidiasis with visible clinical signs. Even though 72 percent of parents/guardians reported their child had a regular source of dental care, only 49 percent had received a dental cleaning and 44 percent had dental radiographs in the past year, reflecting a low prevalence of preventive dental care in this group.

We found a surprisingly low prevalence of oral candidiasis (<1 percent), and *Candida* carriage in saliva (8 percent) given that only 27 percent of the participants were taking an antifungal at the time of the examination. This is substantially less than the prevalence of oral mucosal conditions reported among adult OTRs. King and colleagues reported an 11 percent prevalence of hairy leukoplakia and a 9 percent prevalence of oral candidiasis among 159 RTRs in the United Kingdom (2). The majority of participants were taking corticosteroids and either cyclosporine or azathioprine as this study was conducted before tacrolimus, sirolimus, or mycophenolate mofetil became available. A recent Spanish study among 90 adult RTRs reported 19 percent oral candidiasis and 13 percent hairy leukoplakia (20). There are few comparative studies of oral mucosal lesions among pediatric

OTRs (21,22). The prevalence of gingival enlargement we observed in pediatric OTRs (25 percent) was similar to what was observed in a group of 115 adult RTRs studied at the same institution (34 percent) (23), and similar to other recently published studies (24,25). Overall, it was lower in our study population compared to earlier studies, likely because participants in these studies were receiving an immunosuppression regimen that was cyclosporine based. In our study, the majority of patients were receiving a tacrolimus-based immunosuppression regimen.

While the prevalence of oral mucosal disease and gingival enlargement was lower than in past studies, the prevalence of caries was high in this group. We found that 43 percent of our study population had at least one carious surface, which is significantly higher than reports from the National Health and Interview Survey (NHANES) III. In the NHANES III report, Vargas and colleagues found that the percentage of children with at least one carious surface ranged from 8.5 percent among 6- to 14-year-old Caucasians to 36 percent among 15- to 18-year-old African Americans and Mexican Americans (26). While the overall caries prevalence was high, we found a lower DMFS–defs score among RTRs (median = 1) as compared to LTRs (median = 4). This difference may be explained by presumed higher serum fluoride levels among RTRs that may occur as a result of poor clearance associated with decreased kidney function in patients with a history of chronic renal insufficiency (27). A low caries prevalence among children with chronic kidney disease has been reported (28), which seems consistent with this hypothesis.

The percentage of children in our study who had seen a dentist in the past year (81 percent) was very similar to the 77 percent reported in NHANES III in 6-18 years old (N = 5,170) (29). Similarly, 72 percent of our study population reported a regular source of dental care compared to 69 percent in 6-18 years old interviewed as part of NHANES III. However, utilization of preventive dental care in the past year was reported in less than half of our study population. In addition to the high caries prevalence, underutilization of preventive dental care is a major concern in a group of medically compromised children who should be closely monitored with respect to their dental health to avoid possibly serious dental infections. Because a high proportion of parents reported they could not find a dentist who felt comfortable treating OTR patients, in addition to access, another challenge facing this population is finding a dental provider who feels clinically competent in evaluating and treating these complex patients. One of the first steps in addressing this challenge is to determine why such a high percentage of dentists (40 percent) would not feel comfortable managing the dental health of solid OTRs. Future research should focus on surveying pediatric and general dentists regarding their knowledge level with respect to dental care guidelines pre- and post-organ transplant. Such a survey should be conducted before and after providing these dentists with information and guidelines on the care of this patient population, and the effect of such intervention could then be tested by administration of a post-intervention survey. The American Academy of Pediatric Dentistry (AAPD) has published a number of guidelines to assist pediatric dentists in the care of patients with special needs (e.g., guideline on dental management of pediatric patients receiving chemotherapy, hematopoietic cell transplantation, and/or radiation; management of persons with special health care needs). To date, guidelines for dental care recommendations among solid OTRs pre- and post-transplant have not been published by the AAPD. However, guidelines for dental care among adult OTRs have been proposed and published in the scientific literature by Guggenheimer and colleagues as follows (30):

- Pre-transplantation dental care guidelines:
  1. Consult with patient's physician.
  2. Perform a dental cleaning/prophylaxis.
  3. Treat all active dental diseases.
  4. Postpone elective treatment.
  5. Remove all potential sources of acute or chronic infection, including partially erupted third molars.
  6. Reinforce oral hygiene and home care instructions.
  7. Initiate daily antibacterial mouth rinses.
- Post-transplantation dental care guidelines (immediate post-transplantation period usually defined as 6 months post-transplant):
  1. Consultation with the physician/transplant coordinator
  2. Emergency care of dental infections only
- Stable post-transplantation period:
  1. Consultation with the physician/transplant coordinator
  2. Frequent recall and prophylaxis
  3. Daily antibacterial mouth rinses
  4. All indicated dental care
  5. No NSAIDs
  6. Consideration of antibiotic prophylaxis for invasive procedures
  7. Screening for oral and head and neck cancers
  8. Corticosteroid supplementation, if necessary
- Post-transplantation rejection period (if applicable):
  1. Consultation with the physician/transplant coordinator
  2. Emergency care of dental infections only

The publication of similar guidelines targeting pediatric OTRs by the AAPD would be the first step in educating pediatric dentists on how to manage pediatric transplant recipient patients. Furthermore, a standard protocol including systematic referral to a pediatric dentist for pre-transplant oral evaluation and care should be developed and adopted by all medical transplant teams. To date, it is not clear whether or not

such referral protocol is standard practice among organ transplant centers across the United States, and future research should focus on exploring dental referral practices in a representative sample of transplant centers.

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