FINAL REPORT

USING CHLORHEXIDINE VARNISH TO PREVENT EARLY CHILDHOOD CARIES

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Maternal And Child Health Bureau
Health Resources and Services Administration

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I. INTRODUCTION

A. Nature of the Research Problem
Dental caries (tooth decay) is the single most prevalent chronic disease of childhood, occurring five to eight times as frequently as asthma, the second most common chronic disease in children. Oral health status varies in the U.S. on the basis of sociodemographic factors. Among children aged 6–8 years the prevalence of untreated decay is 72 percent in American Indians, 43 percent in Hispanics, 36 percent in African Americans, and 26 percent in whites. The Third National Health and Nutrition Examination Survey (NHANES III) found that the prevalence of at least one decayed or filled tooth ranged from 8 percent in 2-year-old children to 40 percent in 5-year-old children. Among American Indians and Alaska Natives (AI/AN), the disease burden is much higher. A 1989 report found early childhood caries in 70 percent of AI/AN 3–4 year-old Head Start children.

Caries in the primary dentition is often referred to as early childhood caries (ECC), which at times may manifest as a particularly virulent form of dental caries that affects infants, toddlers, and preschool children younger than 6 years of age. The effects of early childhood caries may extend beyond pain and infection. It may affect a child’s ability to eat, communicate, and learn. In addition, Acs et al. reported that children with early childhood caries weigh significantly less than their counterparts and are more likely to weigh less than 80 percent of their ideal weight—a diagnostic criterion for failure to thrive. Due to the age of the patient and complexity of lesions, treatment of the more severe forms of early childhood caries is often provided in a hospital-based operating room under general anesthesia. In the U.S. general population, this is an uncommon occurrence. However, in 1997 and again in 1999 one Northwest Indian community found that about 65% of these 3–4 year old children either already had had in-hospital restorations or else met the criteria for needing in-hospital restorations—a rate over 100 times as high as two published reports from administrative databases.

The actual physical lesion of dental caries is the endpoint of an infectious disease process, with the primary etiologic agent being the related bacteria Streptococcus mutans and Streptococcus sobrinus, collectively called mutans streptococci. Research done among predominately white and African American populations found that children become permanently colonized with S. mutans at about 24 months of age, with the primary source of infection being a child’s mother or primary caregiver. The earlier a child is infected with S. mutans, the higher the probability that the child will develop severe early childhood caries. One potential method for delaying acquisition is to reduce the mother’s bacterial level through use of a topical antimicrobial such as chlorhexidine, though this had not been previously tested as an ECC intervention for high risk American Indian children.

B. Purpose, scope, and methods of the investigation
The purpose of this research was to reduce the disease burden from ECC among very high risk AI/AN children through delaying development of ECC by interrupting the vertical transmission of cariogenic bacteria from mother to child by periodic applications of an effective antimicrobial—10% chlorhexidine (CHX) dental varnish—to the mother.

The scope was four reservation-based American Indian communities—two in the Pacific Northwest and two in Arizona.

The method of investigation was a placebo-controlled randomized clinical trial in which the mother received initially 4 weekly applications of the study medication (either active or placebo), followed 6
and 12 months later by a single application of the study medication. The children did not receive the chlorhexidine dental varnish, but each child received a single application of 5% NaF varnish at the visits at age 12 and 18 months of age. This was done because application of fluoride varnish to young children every six months was the standard of care at the time the study was initiated. The six-month spacing of the fluoride varnish application in this trial was based on the published data for its efficacy in 5-year-old children. The child had clinical exams for caries at enrollment and ages 12, 18 and 24 months. The primary outcome variable was the decayed, missing, filled surface (dmfs) score for the child at the conclusion of the study. ‘Success’ was considered to be a 20 percent reduction in the mean dmfs in the active compared to the placebo group of children. This clinical trial was approved by the Food and Drug Administration as a Phase III Clinical Trial under Investigational New Drug (IND) #45,466.

II. REVIEW OF THE LITERATURE

Dental Caries—An Infectious and Transmissible Disease: Landmark experiments in the 1960s established that dental caries results from an infectious disease, with the primary etiologic agents being mutans streptococci (*Streptococcus mutans* and *Streptococcus sobrinus*) and to a lesser extent lactobacilli. In a study of an African American population, children became permanently colonized with mutans streptococci between the middle of their second year and the end of their third year of life, during a so-called “window of infectivity”. The major reservoir from which infants acquire mutans streptococci is their mother or primary caregiver. The evidence for this concept comes from several clinical studies that demonstrate that mutans streptococci strains isolated from mothers and their babies exhibit similar or identical bacteriocin profiles and identical plasmid or chromosomal DNA patterns.

Early colonization of the child by mutans streptococci is a significant risk factor for future caries experience. Because early vertical transmission from mother to child is the major mechanism of infection of the child, it is not surprising that suppression of maternal reservoirs of mutans streptococci has been shown to prevent or delay transmission. This is critical because delayed transmission can reduce the prevalence and severity of early childhood caries. The hypothesis that the elimination or reduction of maternal *S. mutans* levels can either prevent or reduce the transmission of *S. mutans* from mother to child has been confirmed by several researchers using different topical antimicrobial agents applied to the mother’s dentition according to different protocols: Kohler, Tenuvuo, Dasanayake.

Early Childhood Caries in AI/AN Children: The Indian Health Service (IHS) is the federal agency whose mission is to provide curative and preventive health care services to the AI/AN population. IHS regularly collects oral health status information on the children it serves. For preschool children, the oral health surveillance system used by IHS is based on the dental patient population served by IHS, tribal and urban Indian dental clinics along with routine screenings at tribal Head Start programs.

The 1999 IHS Oral Health Survey (latest available) screened 2,663 children between 2–5 years of age. About 79% of the AI/AN children had a history of dental decay (at least one tooth with a filling or untreated decay), compared to 25% of NHANES III children. The percentage of AI/AN children with untreated decay was more than three times as high (68% vs. 19%). Worse still, the AI/AN children examined by IHS had a mean dmfs markedly higher than the NHANES III children (Figure 1).
Beginning in the mid-1980s, IHS and tribal programs committed substantial resources towards preventing early childhood caries, including (1) special incentive programs that successfully increased the proportion of optimally fluoridated tribal water systems; and (2) health education efforts based on the recommendations of the Oral Health 2000 Consortium, which were designed to reduce early childhood caries through behavioral interventions (Candace Jones, IHS Dental Program, personal communication). Despite these and other efforts, the average severity of decay in AI/AN preschool children actually increased between 1991 and 1999 (Figure 2). Compared to the IHS survey in 1991, by 1999 there was a statistically significant increase in the number of decayed tooth surfaces (p<0.001), missing tooth surfaces (p<0.001), filled tooth surfaces (p<0.001), and the total number of decayed, missing and filled tooth surfaces (dmfs, p<0.001).

III. Study Design and Methods

Study Hypothesis
Regular application of a 10% chlorhexidine varnish to a mother’s dentition starting when the child is less than six months of age will reduce the incidence of early childhood caries in her young child. Primary outcome variable: The number of decayed, missing and filled primary tooth surfaces (dmfs) when the child is 24 months of age.

Study design: This was a randomized, double blind, placebo-controlled clinical trial to test the efficacy of a 10% chlorhexidine varnish for the prevention of early childhood caries in an American Indian population. We enrolled mother-child pairs when the child was approximately five months of age, and followed the mother-child pairs until the child was approximately 24 months of age, at which time the end of study exam was done. After enrollment, the mothers received four weekly applications of a chlorhexidine or placebo varnish, followed by additional single applications when her child was 12 months and 18 months of age. The mother-child pair received calibrated dental examinations when the child was 5, 12, 18, and 24 months of age. After meeting the inclusion and exclusion criteria, all active caries in the mothers was restored before the time of the first application of the study medication when the child was about 5 months of age.

Population studied: This study recruited American Indian mother-child pairs at four tribal reservation study sites; two in the Pacific Northwest and two in Arizona. The study received approval at each of these sites from the Tribal Council, Tribal Health Advisory Board, CEO, Dental Director, and IRB of record.

Sample selection: Inclusion criteria: Mothers must:
- Have a child about 5 months of age or younger.
- Have active caries themselves, a history of active caries within the last year, or a previous child with documented early childhood caries.
- Have all active decay restored before enrollment in the study.
- Not have an orthodontic appliance.

Study Medication: The study medication was a two-stage 10% chlorhexidine varnish (trade name Prevora®) that was approved in Canada (Drug Identification Number 02046245) in 1993 as a
topical antimicrobial prescription drug for the reduction of *S. mutans* in the oral cavity.\textsuperscript{17} The study medication application involves a three-step process: (1) the teeth are cleaned; (2) the study medication is applied (Stage 1); and (3) a varnish coating is applied to cover and protect the study medication (Stage 2).

**Instruments used:** The study instruments were combined in a single Case Record Form (CRF) as required by the FDA. The principal parts of this CRF collected (a) demographic information and data on potential confounding variables, including concurrent medication usage, side effects, and medical history; and (b) tooth surface specific data for evaluation of caries increment—the primary outcome variable. (Appendix A)

**Calibrated Examinations:** At each of the four sites, calibrated and blinded examiners performed the dental examinations using a visual-tactile method at the d1-d3 (enamel and dentine caries) threshold. Repeat calibrations were conducted approximately every six months by Dr. David Banting, Professor, School of Dentistry, University of Western Ontario.

**Statistical techniques employed**
Descriptive statistics were provided for every variable by treatment group and study site at every visit and observation. Descriptive statistics for continuous variables included mean (median when applicable), standard deviation, minimum, maximum, and sample size. Frequencies and percentages were provided for categorical data.

**Definitions of a carious surface**
- d2 = cavitation into the enamel, but not reaching the dentin
- d3 = cavitation into the dentin
- f = filled (restored) due to caries
- m = missing due to caries
- c = crowned due to caries

All other surfaces were considered non-carious

**Variables Analyzed**

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new carious surfaces (NNCS)</td>
<td>Total count of carious surfaces (dmfs) at last post-baseline visit (by definition, all children had 0 carious surfaces at enrollment).</td>
</tr>
</tbody>
</table>

**Definition of the ITT Population Evaluated**
The intent to treat (ITT) population consisted of the enrolled children of all randomized mothers who completed their enrollment and received the first study medication application. For children who did not complete all four visits according to the study protocol, the observation from the last post-baseline exam was carried forward (last observation carried forward, or LOCF).

**Statistical Analysis**
The main outcome variable of interest was the number of new carious surfaces (NNCS) as defined above. It was analyzed both as a continuous measure and as categorical variable based on two sets of cut offs defined below in Severity Categorizations #1 and #2. The Wilcoxon nonparametric test was used to test the differences between the Active treatment and Placebo groups for continuous measures. The nonparametric test was used because it is more robust when the data has departures from normality, and in the dataset being evaluated there were several large outliers. The descriptive statistics by group and the corresponding p-value based on the Wilcoxon
statistical test are shown in Table 1. The Fisher’s exact test was used to test for differences in the proportion of study participants in two different severity categorization schemas between the Active treatment and Placebo groups. The descriptive statistics for each group by severity and the corresponding p-value based on the Fisher’s exact test are shown in Tables 3-a and 3-b.

IV. DETAILED FINDINGS

A. Mean NNCS: There was no difference between the children in the Active treatment and Placebo groups with respect to the mean number of carious surfaces (Table 1).

Table 1: NNCS at the last post-baseline visit – ITT population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Treatment Group</th>
<th>p-value(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NNCS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>188</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>3.82 (8.18)</td>
<td>3.80 (6.08)</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Min – Max</td>
<td>0 – 67</td>
<td>0 – 27</td>
</tr>
</tbody>
</table>

(1) Nonparametric test
(2) There are 3 outliers (NNCS > 35)—all in Active treatment arm that influence the mean. Without them the mean in Active group is 3.09. The p-value though is not influenced by this outliers since it is based on the Wilcoxon test.

B. Proportion of caries-free children: There was no difference in the proportion of caries-free children in the Active vs. Placebo groups (Table 2).

Table 2: Caries-free children at the last post-baseline visit – ITT population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Treatment Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NNCS = 0</td>
<td>NNCS = 0</td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td>188</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>96 (51.1%)</td>
<td>91 (50.8%)</td>
</tr>
</tbody>
</table>

C. Caries distribution by severity: For additional analysis of the results, children were grouped into caries severity categories as defined below.

1. Severity Categorization #1: Children with:
   a. NNCS = 0
   b. NNCS = 1–5
   c. NNCS ≥ 6
This resulted in a statistically significant shift in the distribution toward less severe scores (Table 3-a).
Table 3-a Severity Scale at 24 months of age (based on Definition #1) of the ITT Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Treatment Group</th>
<th>Overall p-value(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Active Placebo</td>
<td></td>
</tr>
<tr>
<td>Severity (categorization #1)</td>
<td>N</td>
<td>188</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>NNCS = 0</td>
<td>96 (51.1%)</td>
<td>91 (50.8%)</td>
</tr>
<tr>
<td></td>
<td>NNCS = 1–5</td>
<td>58 (30.9%)</td>
<td>38 (21.2%)</td>
</tr>
<tr>
<td></td>
<td>NNCS ≥ 6</td>
<td>34 (18.1%)</td>
<td>50 (27.9%)</td>
</tr>
</tbody>
</table>

(1) Based on Fisher’s exact test

2. Severity Categorization #2: In a subsequent analysis, children who had >0 carious surfaces were categorized into a ‘natural’ distribution of tertiles based on the NNCS scores for children in the Placebo group: 1 – (x-1); x – (y-1); or ≥ y caries, where x and y are the 33% and 67% percentiles of the caries distribution. This resulted in the following three severity groups:
   a. NNCS = 1–2
   b. NNCS = 3–6
   c. NNCS = ≥7.

Using this categorization, there was also a trend for the Active children to be in the less severe groups (i.e., less likely to be in the ≥7 or most severe tertile), but this trend did not reach statistical significance (Table 3-b).

Table 3-b Severity Scale at 24 months of age (Definition #2) of the ITT Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Treatment Group</th>
<th>Overall p-value(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Active Placebo</td>
<td></td>
</tr>
<tr>
<td>Severity (categorization #2)</td>
<td>N</td>
<td>90</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>NNCS = 1–2</td>
<td>31 (34.4%)</td>
<td>27 (31.4%)</td>
</tr>
<tr>
<td></td>
<td>NNCS = 3–6</td>
<td>38 (42.2%)</td>
<td>26 (30.2%)</td>
</tr>
<tr>
<td></td>
<td>NNCS ≥ 7</td>
<td>21 (23.3%)</td>
<td>33 (38.4%)</td>
</tr>
</tbody>
</table>

(1) Based on Fisher’s exact test

D. Number needed to treat: Using the two different categorizations of severity described above, we get somewhat similar results in terms of the number of children in the study population who would need to be treated (NNT) to, in effect, shift one child from the most severe category to a less severe outcome.

1. Severity Categorization #1: NNT = 1/(27.9% - 18.1%) = 10.2
2. Severity Categorization #2: NNT = 1/(38.4% - 23.3%) = 6.6

The short term cost of doing a full mouth restoration under general anesthesia in a child has been variously estimated at $2,000 – $10,000 per case. However, we do not have sufficient data from this study on the subsequent caries experience of the children to determine how many actual operating room cases were prevented by the intervention used.

V. DISCUSSION AND INTERPRETATION OF FINDINGS

A. Conclusions

This trial failed to meet its primary objective of achieving a significant reduction in the mean number of new carious surfaces (NNCS) in the children of the mothers who received the study...
medication (10% chlorhexidine dental varnish) compared to the placebo group. There also was no difference in the mean decayed, missing, filled surface \((dmfs)\) scores for children in the Active vs. Placebo group, and there was no difference in the proportion of children who were caries-free at the final exam between the two groups. There was a very large variation in the end of study caries scores, ranging from a \(dmfs\) score = 0 to a high of \(dmfs = 67\). Surprisingly some of the highest scores were found among those children whose mothers were in the Active treatment group.

After determining that the mean \(dmfs\) and mean \(dmft\) scores were essentially identical for Active vs. Placebo, and that similarly the proportion of caries-free children was essentially the same in Active vs. Placebo, we further analyzed the data to determine whether there had been any shift in the proportion of children who experienced the more severe end of the spectrum of this disease. Mild caries in the primary dentition is a disease with little or no morbidity. In contrast, on the severe end of the spectrum, there is both short term and long term morbidity. Although the efficacy of caries prevention trials are usually assessed by the change in mean \(dmfs\) or mean \(dmft\), it is quite easy to posit a population of children in which an intervention might primarily be effective in children who would have been in the mild (i.e., with little or no morbidity) spectrum of the disease. For example, children who might have had 1 or 2 mild lesions without the intervention might have no caries with the intervention. Likewise, it is possible to posit a population in which a given intervention might be relatively effective in preventing severe disease, while not as effective in preventing milder disease. This exact paradigm has been observed in the evaluation of the efficacy of vaccines against pediatric infectious disease. Specifically, a metanalysis was done on the effectiveness of the varicella (chickenpox) vaccine years after licensure. It was found to be 85 percent effective in preventing all clinical cases of the disease, but 100 percent effective in preventing severe disease.

Unfortunately, there is no nationally or internationally agreed upon definition of severity of caries in the primary dentition. The American Association of Pediatric Dentists (AAPD) defines ‘severe early childhood caries’ as a spectrum ranging from, on the low end, 1 non-cavitated carious lesion on the smooth surfaces for children less than 36 months of age. Despite this definition, in many American Indian communities a child with a single smooth surface lesion at that age would be considered to have mild or inconsequential disease. For this reason, we decided to analyze the data using two different severity scales that would seem to correlate much better with actual morbidity for the child. The first was based on expert opinion, and defined ECC into three groups of children determined by their end of study \(d_2mfs\) count scored at the \(d_2\) or cavitated level rather than the \(d_1\) or non-cavitated level. Given that the children were enrolled at 5–6 months of age, the start of study \(dmfs\) score was always 0, so the end of study \(dmfs\) score is equivalent to the number of new carious surfaces (NNCS):

1. \(NNCS = 0\)
2. \(NNCS = 1–5\)
3. \(NNCS = ≥5\)

Our rationale for this was that based on decades of anecdotal experience in American Indian communities, any child who has 5 or more cavitated carious surfaces at 24 months of age has a very high probability of progressing to rampant caries in the primary dentition, usually requiring restoration under general anesthesia because of the extensiveness of the caries and inability of the young child to cooperate. Using this categorization, we found that a smaller proportion (18.1% compared to 27.9%) of Active children were in the most severe category compared to the Placebo group. We hypothesize this would mean fewer children would require restorations under general anesthesia.

Because this categorization was based on expert opinion rather than a national standard, we also analyzed the outcomes by a ‘natural’ categorization that we based on the observed distribution of
caries in the placebo group. Specifically, all children in the placebo group who had an end of study caries score of >0 were listed by order of their caries scores. This list was divided into tertiles (33% each) of scores, which turned out to be (a) 1–2; (b) 3–6; and (c) ≥7. We then compared the distribution of the Active vs. Placebo children using this ‘natural’ distribution, and found that there was a trend similar to the more arbitrary categorization described above (23.3% compared to 38.4%), though it did not reach statistical significance.

B. Explanation of study limitations
There are several possibilities why we did not have a more robust reduction in caries among the Active group study children.

1. Chlorhexidine has a long history of use in caries prevention trials. Some studies have found it efficacious, while others have not. The level of efficacy seems to depend on the population being studied. Our hypothesis was that in a population in which there is both a high prevalence and high severity of caries, the chlorhexidine would have maximum efficacy, but this may not turn out to be the case. There could be special characteristics of American Indian women such that the chlorhexidine dental varnish was less effective than expected. Also, it is possible that a dosing frequency found efficacious in another population may not have been as effective for our population. Unfortunately, for financial and logistical reasons we were unable to include a microbiological component to our trial to determine any changes in the level of cariogenic bacteria.

2. As mentioned as a weakness in our original study proposal, the trial was based on the preponderance of data from other studies showing that the majority of children acquire their cariogenic bacteria (especially *S. mutans*) from their mothers regardless of whether there are other adults who care for them or other children in the household. Although the proportion of children with this vertical transmission varied somewhat among different investigators, on average approximately 70% of *S. mutans* seemed to be acquired from the mother in other populations. However, a recent report from Mitchell et al. found that among children with the severe end of the spectrum of caries in the primary dentition vertical (maternal) transmission was not the predominant mode, with 59% of the children having no isolates that matched the mother’s. If this same proportion is valid for the American Indian communities we studied, clearly the potential efficacy of the intervention would have been considerable reduced.

3. Last, and probably of most importance, our treatment intervention was delivered to the mothers—not directly to the children. Given that reducing caries in the children is the primary goal, it would obviously be preferable to have an efficacious intervention that could be used directly with the children rather than an indirect one such as interrupting maternal transmission of cariogenic bacteria. At the time our study was begun in 2004, there were no FDA-approved products with an indication of reducing cariogenic bacteria among children. Although that is still the case at the conclusion of our study in the year 2010, there are three potential interventions that have been tested and are in various stages of the FDA approval process that can be applied directly to the children. (See below under ‘Further Research.’)

C. Policy implications
As evidenced by two recent American Dental Association-sponsored Symposia on ECC among AI/AN children, there is increasing awareness of the great health disparity for AI/AN children from caries in the primary dentition. Given the lack of effectiveness of any of the current standard ECC-prevention efforts, including community water system fluoridation, application of fluoride varnish, and counseling the parents on diet and oral hygiene, there is increased attention on controlling cariogenic bacteria to reduce the incidence of caries in these children. Given the very limited benefit from our randomized controlled clinical trial in the population of interest, this would seem to suggest that efforts might be more effective that address the cariogenic bacteria in the children directly rather than trying to interrupt the transmission, which may be either vertical or horizontal. The ideal product would seem to be one that has a very high safety profile in young children and
that can be applied in non-dental clinic settings by non-dental staff. This would shift the focus to pediatric and medical clinics where the children are already being seen on multiple occasions in the first two years of life.

D. Suggestions for further research
Given the lack of effectiveness of any interventions used to date to control the severe end of the spectrum of caries in the primary dentition among AI/AN children, there is the obvious need for additional research to test other products. Some promising agents include the following:

1. Glass ionomer sealants are now being used to arrest incipient caries in young children, and are being found to likewise be efficacious in preventing new caries in the tooth surfaces it covers. There is interest in developing a new formulation of glass ionomer sealant that can be used entirely as a preventive agent, and that could be applied by non-dental professionals. There are some reports that the presence of hypoplastic enamel is a major contributor to the most severe end of the spectrum of caries in the primary dentition. The hypoplastic enamel is a risk factor in that it provides a surface that cariogenic bacteria can more easily adhere to, and once the bacteria are present the defective enamel provides very little protection from rapid demineralization and cavitation.

2. A 1.0% flavored chlorhexidine gel has been developed by the University of Iowa College of Dentistry and has been used directly with children in Phase I FDA-sanctioned trials. This product has the great advantage of being in a toothpaste-like formulation and having a pleasant raspberry flavor that children like. Preliminary studies in Iowa Head Start children have found both a high level of acceptance as well as high efficacy in reducing the children’s levels of *S. mutans*. Further clinical trials in high risk children in AI/AN communities would seem to offer promise for a more effective intervention product.

3. Last, and potentially most promising, a product containing silver diamine fluoride has had substantial usage for a number of years in Japan, Australia and Brazil. It is applied to the children’s dentition in the same way as the currently available NaF varnish. A recent report found a remarkable efficacy in (a) immediately arresting any extant caries (>90%), and (b) preventing development of new caries for up to a year (>70%). This product is currently being reviewed by the FDA for approval for marketing in the U.S. If it becomes available, it would appear to have a great advantage over the 10% chlorhexidine varnish we used with the mothers in our trial in that it could be applied directly to the children’s dentition in a variety of non-clinic settings.

VI. List of Products

Manuscripts

1. Using chlorhexidine dental varnish to control rampant early childhood caries among AI/AN children; L. D. Robertson, Kathy Phipps, John Symington, Brenda Trugeon, Niko Kaciroti (in progress)

2. Efficacy of chlorhexidine dental varnish in reducing caries in young AI/AN mothers with infants; L. D. Robertson et al. (planned)

Presentations


APPENDIX A: DATA COLLECTION FORMS
M. REFERENCES