A Simulation Model for Designing Effective Interventions in Early Childhood Caries

Project Partners

After initially working separately on the utilization of Systems Dynamics to create a simulation for designing effective interventions in early childhood caries (ECC), Colorado's Department of Public Health and Environment (CDPHE) and the Children's Dental Health Project (CDHP) decided on a collaborative effort. This project was supported in part by a grant to Colorado – "HRSA Targeted State MCH Oral Health Service Systems Grant Program HRSA-07-039." CDHP's contribution to the project was made possible with funding from CDC Cooperative Agreement Grant Number 10593762.

Project Phases

- Phase 1: Formal partnership developed and systems dynamics consultant identified for expert staff support
- Phase II: CDHP convened a stakeholder group with expertise in ECC research (cariologists), reimbursements (insurance), medical/pediatric health, state perspectives, and other areas. Colorado also convened a group designed to "set the parameters" of the model for the state.
- Phase III: Model was quantified with extensive data available from national sources (NHANES, MEPS) and at the state and county level (BRFSS, Child Health Surveys).

About CDHPE and CDHP

Colorado Department of Public Health and Environment's 2010 Strategic Plan states that the "department serves the people of Colorado by providing high-quality, cost-effective public health and environmental protection services." The Oral Health Unit is part of the Prevention Services Division at CDPHE. For additional information visit:
www.cdphe.state.co.us/pp/oralhealth/oralhealth.html

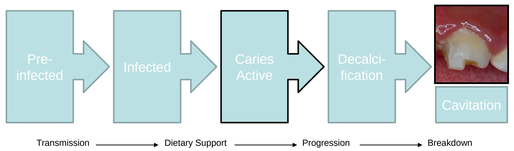
The Children's Dental Health Project (CDHP) is a national non-profit organization with the mission of creating and advancing innovative solutions to achieve oral health for all children. CDHP works to eliminate the barriers to preventing dental disease to ensure that all children reach their full potential. For additional information on this project, visit us at www.cdhp.org or contact Marcy Frosh at mfrosh@cdhp.org.

Project Frame – Problem, Methods, & Model

Problem:

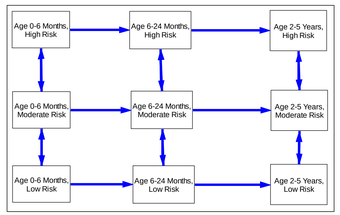
Early Childhood Caries is an aggressive disease process leading to rapidly progressing tooth destruction in young children. ECC is an infectious, fluoride-mediated, diet-dependent disease process that results in cavities. It is predictive of lifelong caries. ECC is common, increasing and consequential. Current management is surgical, which results in high cost, high stress, repair without protection against future risk.

Alternative Interventions:
1. Primary Prevention
2. Secondary Prevention/ Disease Control



Methods:

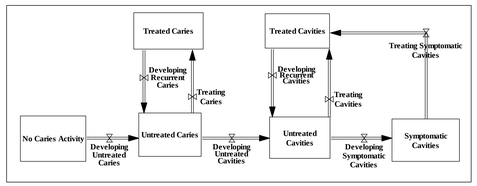
Systems Dynamics (SD) is an approach to understanding the behavior of complex interactive systems over time by answering the "what if" question by accounting for multiple interdependent variables that interact over time. SD allows comparisons and assessments of interventions and combinations of interventions to assess possible impacts. It also utilizes disparate data sources to "fill in" knowledge gaps to make projections. SD has been used extensively for health and healthcare.



Basic Framework Reflecting Possible Changes Over Time:
As Children Age They Can Move Between ECC Risk Levels

Model:

Basic Model Structure considers all possible combinations of progression and outcomes



Note: With appropriate data inserted, model could represent any state or large population area.

Project Results

Possible Interventions That Can Be Explored With the Model

- Educational programs that reduce the consumption of sugary drinks and other harmful practices that contribute to the growth of *S. mutans*.
- Programs aimed at reducing the transmission of S. *mutans* from caregivers to children using xylitol gum, chlorhexidine, or other substances.
- Use of xylitol products directly with older children.
- Aggressive screening for and treatment of caries (pre-cavities) to reduce progression to cavities.
- Expanded use of fluoride varnish.
- Focused preventive care and education for children who already have cavities to reduce recurrence rates.
- Rigorous tooth brushing programs with fluoride toothpaste.
- Expansion of Community Water Fluoridation (CWF) to the entire population.
- Motivational interviewing with a strong educational component.
- Combinations of the above.

Example:

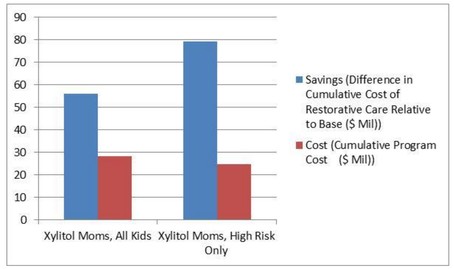
Treatment of Mothers with Xylitol to Prevent Transmission of *S. mutans*

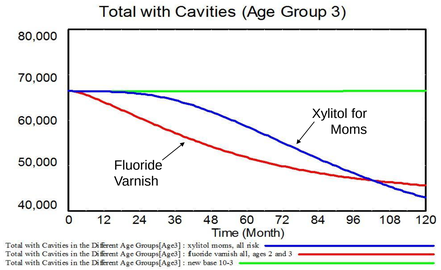
Assumptions:

- 88% reduction in age group 2 (6-24 months) and 64% reduction in age group 3 (2-5 years) in *S. mutans* colonization for children whose mothers were treated with Xylitol
- 73% reduction in development of caries in children without *S. mutans* colonization.
- Intervention applied to mothers of children in age groups 1 (0-6 months) and 2 only; delayed effect on children in age groups 3 as children who did not benefit from treatment age out and those whose mothers were treated into that group.
- $100 average one-time cost per mother.

Simulations:

1. Xylitol treatment for Moms of all kids in Age groups 1 and 2
2. Xylitol treatment for all kids





Interventions aimed at the **youngest children** will take longer to affect the entire population, but will ultimately have a more profound effect in reducing prevalence as the impact percolates into older groups as children age. Interventions limited to the **highest risk** (lowest income) groups of children will have the greatest impact per dollar spent because of the greater relative risk of ECC in that population. Limited budgets are best spent on these groups.

Targeting children who already have cavities can also be effective because of the high rate of re-occurrence.

Combined interventions that target ECC at several stages of development the disease process are likely to the greatest impact. Primary prevention provides the greatest leverage, but it is also productive to limit disease progression.

Note: Information on this project and other simulation modeling for oral health is being developed into a series of articles by authors that include: Anselmo T, Edelstein B, Frosh M, Hirsch G, Maas W, Tate A.