White Paper on Community Water Fluoridation

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Abstract

Louisiana's population demographics, health trends, and the pervasive lack of available dental services places the state at increased risk for poor oral health. Oral health costs in the US totals over $60 billion, annually. Preventative oral health measures that reach all members of the population, and that are cost effective are needed to improve the oral health of the state's population and reduce the cost burden of oral health services. Community water fluoridation has over 60 years of research supporting its ability to provide a cost effective, safe prevention method of dental decay to all members of a community regardless of age, socio-economic status, or ability to access dental services. While opponents of fluoridation purport fluoride exposure causes a variety of negative health effects, the prevailing scientific evidence demonstrates no association between water fluoridated at levels recommended for community water fluoridation and negative physical health effects. To that end, expansion of community water fluoridation in Louisiana is needed to decrease oral health disparities. Presently, less than 40% of the Louisiana population receives fluoridated water.

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Importance of Good Oral Health

Simply put, good oral health is crucial to one's overall health. While oral health is traditionally thought of as the health of the mouth- teeth, gums, jawbone, and craniofacial tissues, oral health affects other body systems and, in turn, is easily influenced by other body systems. Thus, it is necessary to not consider oral health as an isolated, independent aspect of health. While many are familiar with the common oral health problems- cavities, tartar build up, gum disease, and tooth loss, which in and of themselves are painful, there is research evidence that demonstrates that oral health contributes to diabetes, respiratory diseases, heart disease, and sleeping problems (Minister of Health, 2008). Furthermore, there is research suggesting that poor oral health may contribute to an increased risk of pregnant mothers delivering preterm, low birth weight babies (Clothier, Stringer, & Jeffcoat, 2007; Minister of Health, 2008; Buduneli, Baylas, Buduneli, Turkoglu, Kose, Dahlen, 2005; Mitchell-Lewis, Engebretson, Chen, Lamster, Papapanou, 2001; Horton, Boggess, Moss, Jared, Beck, Offenbacher, 2008). Poor oral health and its effects concerning the mouth and other systemic effects, which cause pain, impairment, and loss of function, contributes to an overall decreased quality of life.

Populations at Risk For Poor Oral Health

Traditionally, poor oral health practices are found among disadvantaged and socially marginalized populations due to their inability to access or afford adequate dental care. While all persons may be considered at risk for poor oral health, other subpopulations are of major concern. These populations consist of, but are not exclusive to, children, the elderly, smokers, those with a poor diet, certain races, those of lower economic status, and those who are uninsured.

First, young children are at risk for poor oral health because of their limited abilities to care for themselves. Children are dependent on their caregivers to obtain the resources necessary for good oral health, including possessing a toothbrush and toothpaste or experiencing a visit to the dentist. Children are also at risk for poor oral health because, without supervision, they are prone to skip hygiene practices like brushing their teeth, or, due to their limited dexterity and their hastiness, may do a poor job of brushing. While these practices themselves may lead to cavities, children are at a greater risk because until the age of 12, the enamel of their teeth is not mature and is therefore more vulnerable for carious (cavity- causing) attacks (American Dental

Association, 2005b). Among US children, dental caries is the most common chronic disease, occurring at a frequency of 5-8 times more than asthma, (the second most common chronic disease). More than 50% of children have had at least one cavity by the time they reach the 2nd grade. By the completion of high school, 80% of children have cavities. Of adolescents aged 12-19, 20% are found to have untreated tooth decay. Children from lower income families are nearly twice as likely to have decay as children from higher income families. Based on NHANES data, 6-8 year old children who are African American and Mexican experience greater rates of untreated dental decay compared to whites, 35% and 43%, respectively, compared to 22 percent. Children whose parents possess less than a college education are also at a greater risk for untreated dental decay (Office of Disease Prevention and Health Promotion, 2005). The rate of dental sealants (plastic coatings applied to molars to prevent decay) on children's teeth is also poor- of children aged 6-19 years old, only about a one-third have dental sealants on their molars (Centers for Disease Control, 2009).

The second population of concern is the elderly, who, like children, may also rely on others for their care. Also, due to their frailty, their decreased general health, and increased use of medicines, their oral cavity may become an environment ideal for carious attacks. Additionally, limited financial means may make dental services unattainable for the elderly. According to the CDC (2009), of adults aged 65 years or older, 25% have lost all of their teeth.

Non-elderly adults are also burdened by poor oral health, with 30% of adults having untreated dental decay and 85% having had a cavity in their lifetime. This is particularly noteworthy because more than ever before, adults are retaining their permanent teeth, primarily as a result of water fluoridation, which, thereby causes an increased need to stave off the effects of poor oral health, and provide these adults with the opportunity to be painfree and to retain function of their teeth (Office of Disease Prevention and Health Promotion, 2005). Racial disparities in dental treatment, as well as educational disparities are also prevalent in adults. As seen in children, non-Hispanic whites are more likely to visit a dentist than Hispanics and non-Hispanic blacks. Persons with some college education are twice as likely to visit a dentist compared to those with less than a high school education (Office of Disease Prevention and Health Promotion, 2005). Lack of medical insurance among adults in the US further contributes to poor dental health. As Table 2 illustrates, almost half of US adults do not have any insurance.

Type of insurance	% of persons in US
Private	44%
Public (Medicaid, CHIP)	9%
Other	2%
Uninsured	45%

Table 2: *Types of medical insurance and the percentage of the US population that is covered by that type of insurance (Office of Disease Prevention and Health Promotion, 2005).*

There is also concern of poor oral health associated with certain lifestyle and diet choices. Smoking is a major risk factor for oral disease and cancer. According to the Centers for Disease Control (2009), half of the cases of severe gum disease in the US are a result of cigarette smoking, with smokers being three times more likely than non-smokers to have gum disease. Tobacco smoke is very damaging to the gums as it deprives the gum tissue of oxygenated blood and nutrients, and the toxins of smoke are carcinogenic. It is estimated that approximately 30,000 new cases of oral cancers will be diagnosed in 2009 (Centers for Disease Control, 2009). Diet choices are also of concern for oral health, as diets with considerable sugar content, as well as acids do not bode well for teeth. Soft drinks are a major source of sugar, with some nondiet varieties containing up to 11 teaspoons of sugar per serving. It is estimated that 1 out of every 4 drinks consumed in America is a soft drink, thus it should come as no surprise that in 2000, Americans consumed 53 gallons of soda pop per person (Beverage Institute for Health and Wellness, 2006). Additionally, the World Health Organization (WHO) considers those who have increased alcohol consumption to be at risk for poor oral health as the sugars in alcohol can be carious (Petersen, 2008).

Because of the evident disparities in care, access, and the potential for decreased quality of life, the US Department of Health and Human Services (DHHS) has made oral health one of the 28 focus areas for the Healthy People 2010 Goals (specifically focus 21) (U.S. Department of Health and Human Services, 2005). The over-arching Healthy People 2010 goal for oral health is to prevent and control oral and craniofacial diseases, conditions, and injuries, and improve access to related services. The 17 objectives for achieving the Health People 2010 oral health goal are included as Appendix I.

Cost of Dental Care

The cost for dental care in America is quite expensive. It is estimated that annually, the US spends $60 billion on dental services. Of that $60 billion, $451 million is devoted to inpatient dental-related hospital charges (Truman et al., 2002).

Data from Medicaid-eligible children in Louisiana further illustrates the costliness of dental care. Upon comparing Medicaid-eligible children aged 1-5 years old, those that received dental care in a hospital incurred a mean cost for care of $1,508. Medicaid children aged 1-5 years old that did not receive dental care in a hospital incurred a mean cost of care of only $104. The children who sought dental care in the hospital represented only 5% of the study population, but were responsible for 45% of total dental costs. The dental costs for the children that sought care in the hospital totaled over $3 million (Griffin, Gooch, Beltran, Sutherland, & Barsley, 2000). Additional research from Louisiana shows that of Medicaid eligible children 1-5 years old, those that live in fluoridated parishes incur dental service charges of approximately $15 to $60 less than those residing in non-fluoridated parishes. Also, it was found that children residing in non-fluoridated were more likely to receive costly caries-related treatments and operation room (OR)- based care than their counterparts residing in fluoridated parishes (Centers for Disease Control, 1999b).

Oral Health in Louisiana

Louisiana, based on racial and education-related factors, is at increased risk for poor oral health. As discussed above with regards to national trends, African Americans are at risk for poor oral health. Louisiana's population, based on 2004 US Bureau of the Census and National Center for Health Statistics, showed that Louisiana's black population was more than twice that of the national average, 33.3% versus 12.8%. Thus, Louisiana has a sizeable population at risk for poor oral health based on racial inequities. Furthermore, the level of educational attainment in Louisiana poses a risk for poor oral health, as we know from national data that adults with less education are at increased risk for poor oral health and children whose parents have low levels of education are also at risk. The 2000 US Census Bureau found that 80.4% of the population had achieved a high school diploma or more, and 24.4% had achieved a bachelor's degree or more. Data from 2000 demonstrate Louisiana's education attainment is significantly below the national average. In 2000, only 74.8% of the Louisiana residents over 25 years of age had achieved a high school diploma, and only 18.7% had earned a bachelor's degree (Bauman & Graf, 2003). Due to the low education attainment in Louisiana, a significant proportion of the state's population is at risk for poor oral health, as are the children of this portion of the population.

Additionally, the health status of Louisiana residents is cause for concern for poor oral health, with the disease states contributing to poor oral health or as a result of poor oral health. In 2004, diseases of the heart and diabetes accounted for 30% of deaths in Louisiana, 26% and 4% of deaths, respectively. Since 1996, Louisiana has possessed the highest age-adjusted rate of death due to diabetes from compared with other states (State of Louisiana Department of Health and Hospitals, 2007). Diabetes and heart disease have been linked to contribute to or be affected by oral health (Mayo Clinic staff, n.d.; Maryland Department of Health and Mental Hygiene Family Health Administration, n.d.; American Dental Association, 2009), thus Louisiana, based on health and disease status, is at increased risk for poor oral health.

Information from the Louisiana Oral Health Program further illustrates the oral health needs in Louisiana. In 2002, 871 third grade students in 7 parishes of the state participated in the LA Basic Screening Survey (BSS). This study revealed that 37.7% of the children had untreated caries, 63.5% had had previous dental caries, 18% had sealants. For comparison, in 1998, 38% of screened 3rd graders in Louisiana had untreated caries and only 22% had sealants (State of Louisiana Department of Health and Hospitals, 2007). A reduction in prevalence of dental sealants was determined. This finding reveals that in 2002, fewer children received preventive dental care than in the 1998 survey results. As seen in Figure 1, despite increasing enrollment for Medicaid and LaCHIP, eligible children (classified as Early and Periodic Screenings Diagnosis and Treatment – EPSDT) in Louisiana are consistently failing to visit a dentist, with only 26-35% receiving at least 1 visit per year (State of Louisiana Department of Health and Hospitals, 2007).

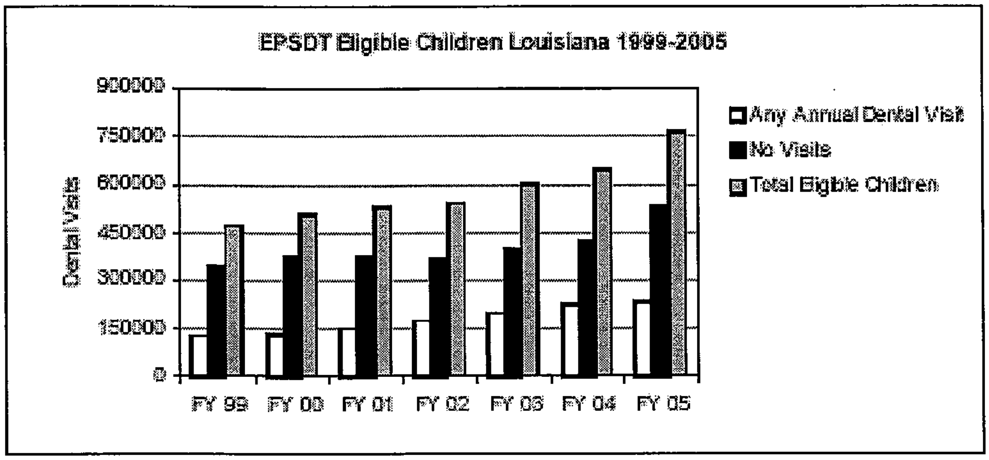

Figure 1: *Number of Medicaid and LaCHIP eligible children in Louisiana and their dentist visiting propensities for the years 1999-2005. (State of Louisiana Department of Health and Hospitals, 2007)*

Presently, approximately 667,000 children in Louisiana are covered under state medical coverage, with approximately 126,000 participating in LaCHIP and approximately 540,000 participating in Medicaid. Assuming the rate of only 35% (based on Figure 1) of Medicaid/LaCHIP eligible children visiting a dentist once per annum, approximately 433,550 children are left with potentially no dental care (due to failure to seek care) beyond in-home hygiene practices. Additionally, 64,000 children in Louisiana have no health coverage and are unlikely to receive clinical dental care (State of Louisiana Department of Health and Hospitals, 2009b). This leaves approximately 500,000 children at risk for poor oral health because of no dental coverage or because of a lack of seeking the benefits provided to them through the state medical coverage.

Dental health among adults in Louisiana is no better. More than 546,000 adults in Louisiana are without health insurance and are likely to not receive clinical dental services. This population total, added to the potential number of children who are at risk for not receiving clinical services (433,500), totals to almost 1.2 million persons in Louisiana being at risk for poor oral health. While in theory all members of the population are at risk for poor oral health, even if the recommended oral hygiene practices are followed, these 1.2 million persons are at an even greater risk for poor oral health.

Further compounding any efforts to achieve ideal oral health standards in Louisiana is the overall lack of dental services. Of the 64 parishes in the state, 56 are considered Health

Professional Shortage Areas (HPSAs) by the Health Resources and Services Administration (HRSA). Figure 2 below illustrates which parishes are considered dental HPSAs (State of Louisiana Department of Health and Hospitals, 2009a)

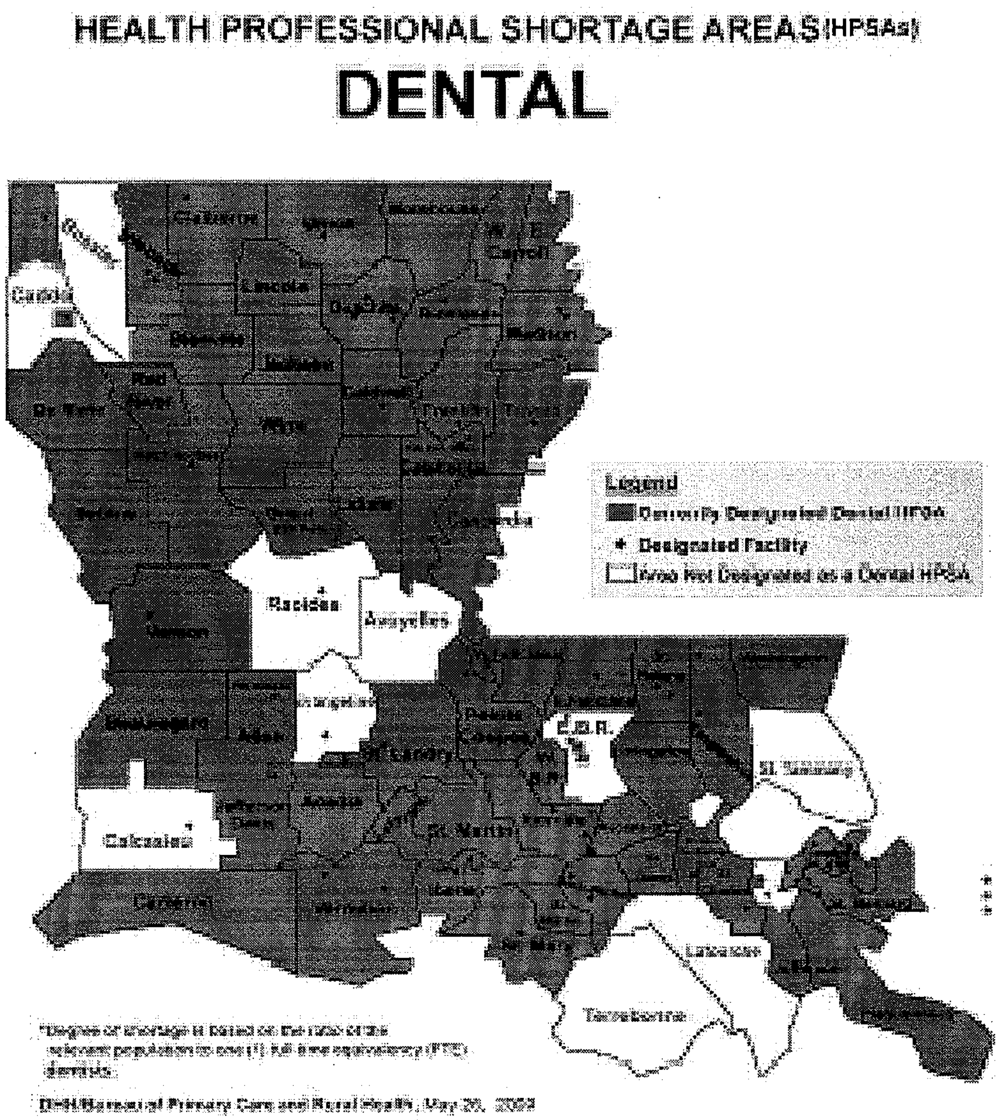

Figure 2: *Dental Health Professional Shortage Areas in Louisiana as of May, 2009.*

It is because of the heightened risk among Louisiana's population for poor oral health due to population demographics, disease states, and variable medical coverage that supports the need for community water fluoridation.

Community Water Fluoridation

Louisiana's oral health disparities data clearly support the need for community water fluoridation in Louisiana. Community water fluoridation began in January 25, 1945 in Grand Rapids, Michigan. This city was the first in the world to adjust its water fluoride concentration to the adjusted fluoridation standard. More than 60 years later, community water fluoridation continues to be the most effective intervention in reducing dental decay. In 1999, the CDC named community water fluoridation one of the top ten greatest achievements in public health due to water fluoridation's ability to provide oral health prevention to all segments of a community regardless of a person's age, education, income level, race, or means to access dental care (Centers for Disease Control, 1999a; Centers for Disease Control, 2005). Additionally, the WHO issued the following statement: "Providing that a community has a piped water supply, water fluoridation is the most effective method of reaching the whole population, so that all social classes benefit without the need for active participation on the part of individuals" (American Dental Association, 2005a, p. 22).

The Benefits of Fluoride Exposure

Fluoride works both systemically and topically. When teeth are developing beneath the gums, fluoride is deposited into the tooth surface making it stronger and providing long-lasting protection against decay. Secondly, when you eat foods, food particles get stuck between teeth and between the teeth and the gums. These food particles have sugars that the bacteria existing in the mouth consume. All foods have sugars, even fruits and vegetables, not just sweets like cookies and candies. When the bacteria eat the sugars, lactic acid is released, which causes the mouth's over all pH to be lowered to a point where the enamel of the teeth can begin to break down. If the enamel is broken down (demineralized) at a faster rate than it can be repaired (remineralized), cavities will develop. Enamel repair is aided by fluoride. Fluoride ions are able to repair some of the broken molecules in the enamel, and it also enhances the deposition of calcium and phosphate, both of which are needed for remineralization. Also, when you drink fluoridated water, you are not only allowing the fluoride to wash over your teeth, but it also becomes part of your saliva, making it further available to help with remineralization (American Dental Association, 2005a).

Despite the availability of fluoridated products like toothpastes and mouthwashes, fluoridated water is still necessary to prevent dental decay. Not everyone is able to brush as often or as adequately as is recommended. Fluoridated water, therefore, is a method of providing a level of fluoride that is helpful in fighting tooth decay in times when brushing is not possible. Additionally, not everyone is able to acquire or afford the fluoridated mouth rinses, at home treatments, or even visit a dentist regularly. Fluoridated water is of tremendous benefit to these individuals.

Effectiveness of Community Water Fluoridation

The importance of fluoridated water preventing tooth decay and thus warding off cavities and other oral health problems has been documented since 1945 when Grand Rapids initiated fluoridation. A vast quantity of research exists supporting fluoridation. Additionally, the support of fluoridation comes from all over the world.

To illustrate the effectiveness of fluoridation preventing dental caries, studies comparing similar communities and their fluoridation status will be discussed. Such a study was conducted by Szpunar and Burt (1988) in Michigan. Four communities were used with the following water fluoride levels: 0.0 ppm, 0.8 ppm, 1.0 ppm (adjusted to achieve level), and 1.2 ppm. It was found that of the children 6-12 years old residing in these four communities, 65% were caries-free. The residence of the caries-free children was positively associated with fluoridated communities. Also, the children from 1.0 ppm and 1.2 ppm communities had better mean DMFS (Decayed/Missing/Filled Surfaces) and DMFT (Decayed/Missing/Filled Teeth) scores. (NB: the higher the DMFS or DMFT score, the more teeth or tooth surfaces affected by decay or caries) The 0.0 ppm community had the worse DMFS and DMFT scores. Research from the National Institute of Dental Research found that children who had lifelong exposure to fluoridated water had mean DMFS scores 18% lower than children never having lived in a fluoridated community. Upon controlling for alternative fluoride exposures, the children from the fluoridated community had mean DMFS scores that were 25% lower than children from nonfluoridated communities (Brunelle & Carlos, 1990). Similar results were found in fluoridated communities in Japan. The mean DMFS scores for 10-12 year olds in Japanese communities with fluoridation levels of 0.8 to 1.4 ppm was 53.9 – 62.4% lower than the means DMFS scores for children in non-fluoridated Japanese communities (Tsutsui, Yagi, & Horowitz, 2000). These studies conclude that exposure to fluoridated water yields stronger, less carious teeth.

Next, studies that examine the duration of fluoride exposure and caries prevention will be discussed. Grembowski, Fiset, & Spadafora (1992) concluded that when controlling for all other factors, for every year of fluoride exposure, the number of DMFS surfaces was reduced by 0.29. They also found that adults who had been exposed to fluoridated water for most of their life had 44% fewer decayed/filled surfaces (about 12 surfaces total in the mouth) than adults never exposed to fluoridated water. Adults who were only exposed to fluoridated water during the years their teeth were developing below the gums had 8 fewer decayed/filled surfaces. Adults who were exposed to fluoridated water only after age 14 (after enamel was fully mature) had nearly 6 fewer decayed/filled surfaces. These findings support that fluoridated water supplies are beneficial for children and adults.

Lastly, the effectiveness of community water fluoridartion can be deduced from the change in dental health in communities that have ceased fluoridation. In 1960, Antigo, Wisconsin was such a community. After 11 years of fluoridation, Antigo stopped fluoridating. After only 4 years without fluoridated water, DMF rates had increased to such a level that they were on par with communities in Wisconsin that had never experienced community water fluoridation at all (Lemke, Doherty, & Arra, 1970). Galesburg, Illinois experienced a similar change in fluoridation status when in 1959 it stopped using naturally fluoridated water of 2.0 ppm and switched to water from the Mississippi River (less than or equal to 0.1 ppm fluoride). It wasn't until 1961 that community water fluoridation was implemented; for 2 years Galesburg was without the benefit of fluoridated water. In the 2 years between the switch to the Mississippi River water and fluoridation implementation, the number of caries-free 14 year olds decreased by 10%, and a 38% increase in carious lesions was experienced (Way, 1964). Another example of this scenario comes from northern Scotland where water fluoridation to 1.0 ppm was ceased and returned to a natural state of 0.2 ppm. After 5 years of this change, mean clinical and radiographic DMFT scores increased by almost 30%; DMFS scores increased by 40%. The number of caries-free children decreased and the mean number of extracted teeth rose over 60% (Stephen, McCall, & Tullis, 1987).

It should be noted; however, that exposure to the benefit of fluoridated water is not limited to having to always drink fluoridated water. Food and beverage items produced in fluoridated communities can also introduce the benefits of fluoride to non-fluoridated communities (known as a halo-effect) (American Dental Association, 2005a). In "Quantifying the Diffused Benefit from Water Fluoridation" (2001) it was found that children living in states where over half of the population received community water fluoridation, but where they specifically lived did not have fluoridation, had 26% fewer decayed tooth surfaces when compared to children living in states where fluoridated water was only available in less than 25% of the population. The CDC reports that a child living in a non- fluoridated community within a highly fluoridated state would typically have one fewer cavity as a result of the halo-effect (Centers for Disease Control, 2001).

How Community Water Fluoridation is Executed

Fluorine is reported to be the 13th or the 17th most abundant element in the earth crust (Weinstein & Davison, 2004). Fluorine is widely distributed throughout the earth's crust as the fluoride ion. Fluoride can be found in surface water, ground water, and ocean water in concentrations typically between 0.2 and 5.0 parts per million (ppm). Higher and lower concentrations do occur. Excessive amounts that occur naturally in drinking water must be removed; at this time there are no public water systems in Louisiana that require efforts to remove excessive fluoride levels (defluoridation) (Centers for Disease Control, 2008c).

Fluoride levels in drinking water are adjusted by adding fluoride ions in the initial treatment process. In theory, any compound that forms fluoride ions in water can be used. For practical reasons there are three commonly used compounds. These compounds and the American Water Works Association (AWWA) standards that address them are:

Chemical name	**Chemical Formula**	**Form**	**AWWA Standard**
Fluorosilicic acid	H_2SiF_6	Liquid	AWWA Standard B703
Sodium fluoride	NaF	Solid (Powder or crystal)	AWWA Standard B701
Sodium fluorosilicate	Na_2SiF_6	Solid (Powder or crystal)	AWWA Standard B702

Table 2: *Common sources of fluoride for community water fluoridation (American Water Works Association, 2004).*

Fluorosilicic acid is a liquid while the other compounds are powder or crystal forms. Some systems are designed to introduce the fluoridating compound as a liquid while others put dry compounds directly into an open channel. In liquid systems, the sodium fluoride and the sodium fluorosilicate are dissolved in holding tanks prior to use, then any one of the three compounds are pumped into the water stream. Positive displacement metering pumps are typically used to inject a specific quantity of fluoride compound. In dry systems, the compound is delivered via bulk handling equipment into an open channel. Calculations are performed based on the treating compound characteristics and the flow rate of the water being treated to determine equipment- operating parameters. Weight of compound delivered is commonly used for a control.

Several factors determine the overall design of any fluoridation system including water flow rates, number of wells or injection points, available space, and chemical costs (American Water Works Association, 2004).

Fluoride levels for optimum oral health benefits have been set by the Centers for Disease Control at a range of between 0.7 ppm and 1.2 ppm, depending on the latitude of a community. As the climate gets colder (with higher latitude), the recommended level of fluoride increases as a reflection of lower drinking water consumption rates. In 1986, the Environmental Protection Agency (EPA) set a Maximum Contaminant Level Goal (MCLG) of 4.0 ppm and a Secondary Maximum Contaminant Level (SMCL) of 2.0 ppm. The MCLG is a non-enforceable health-based goal that is set at a level at which adverse health based effects would not be expected. The SMCL is set as a limit to regulate the aesthetic or cosmetic qualities of the treated water. The EPA also set the Maximum Contaminant Level (MCL) at 4.0 as an economically and technologically feasible limit (American Water Works Association, 2004).

In 2006, the National Research Council Committee on Fluoride in Drinking Water reviewed the 1986 EPA levels and recommended that the MCLG and the SMLC be revisited and that the risk assessment and the criteria for acceptable aesthetic effects be updated (Centers for Disease Control, 2008b).

To ensure that fluoridation levels are being properly maintained, the CDC developed the Water Fluoridating Reporting System (WFRS), an internet-based national database. Per the State of Louisiana Office of Public Health's "Fluoridation Management Program", each fluoridating public water system is to check the levels of treatment chemicals, like fluoride, daily and issue a monthly report to the State. These reports supply the data that is entered into the CDC's WFRS database. Samples of treated water are analyzed by split sampling on a monthly basis to ensure consistent fluoride delivery by weight (Centers for Disease Control, 2008c).

Cost Savings from Community Water Fluoridation

In 2001, the *Journal of Public Health Dentistry* and the CDC (2001) reported that under typical conditions, water fluoridation could be attributed to an annual reduction in dental treatment costs of almost $19 per person living in a large community. For persons living in smaller communities, with less than 5000 residents, the annual savings was still remarkable at almost $16 per person. Such savings are considerable when compared to the average fluoridation cost of a large community (>20,000 people) of $0.50 per person.

An earlier evaluation of communities in Florida found similar costs for fluoridation. Ringelberg, Allen, & Brown (1992) examined the initial start-up costs (including equipment, installation, engineer costs) and operational costs for 44 communities in Florida that had initiated community water fluoridation. These initials costs were annualized (depreciated) at both 2% and 4% for 15 years and then added to the operational costs, which included the costs of chemical supplies, labor, and maintenance/repairs. Initial costs for the 44 communities varied from approximately $7,000 to $191,000 as a result of the number of injection points used and the type of chemical used. The average cost of chemicals was $0.19 per person and the average cost of operation was $0.30 per person. At a 2% rate of depreciation, the total mean cost per person per installation was $1.14/year; at 4% it was $1.25/year. The total mean cost per person across all installations was found to be $0.41 at a depreciation rate of 2%, and $0.45 at 4% depreciation.

More recent data suggests that the average cost for a community to fluoridate its water can range from $0.62 to $3.90 (2004 dollars) per person, per year, depending on the size of the community (Centers for Disease Control, 2005). The CDC (2005) cites that for every $1 invested in fluoridation, the subsequent savings from fewer dental treatments is $38.

These costs per person are orders of magnitude less than the costs associated with poor oral health. The CDC reports that the average cost of fluoridation per person over a lifetime is in general less than the cost to have one cavity filled (Centers for Disease Control, 2005).

Health Risks From Fluoride Exposure

Opponents of fluoridation promote the dangers of fluoride ingestion, however the data used to support their claims are often unfounded and inconsistent with respect to optimally fluoridated water supplies. Nonetheless, the most commonly purported adverse health effects are reviewed below. Additionally, the American Dental Association has conducted extensive research pertaining to the safety of community water fluoridation and has published their findings in *Fluoridation Facts*. A copy of this publication is included with this document as Appendix II.

- **Dental fluorosis**

Dental fluorosis is the change in the appearance of tooth enamel as a result of excessive exposure to fluoride when the enamel of a tooth is developing under the gums. The fluoride exposure causes the enamel to be abnormally porous. The stains (flecks, spots, etc.) associated with dental fluorosis are not evident when teeth first erupt through the gums, but develop over time as a result of the porous enamel absorbing ions like iron and copper (Alvarez, Rezende, Marocho, Alves, Celiberti, & Ciamponi, 2009). It is possible to have dental fluorosis in the primary dentition ("baby" teeth) as well as permanent teeth, but is generally more severe in permanent teeth (Warren, Kanellis, & Levy, 1999). Because fluorosis can only occur in developing teeth, it is not possible to develop cases of fluorosis after the dentition has erupted. Thus, children over 8 years old, adolescents and adults do not develop new cases of fluorosis. It is proposed that the window of risk for fluorosis is between 1 and 4 years of age (Alvarez, Rezende, Marocho, Alves, Celiberti, & Ciamponi, 2009). Fluorosis is only cosmetic and does not affect the function of the teeth. The severity of dental fluorosis is classified on the Dean scale, represented below as Table 3.

Classification	Criteria-Description of tooth enamel
Normal	Smooth, glossy, pale creamy-white translucent surface
Questionable	A few white flecks or white spots
Very mild	Small opaque, paper-white areas covering less than 25% of the tooth surface
Mild	Opaque white areas covering less than 50% of the tooth surface
Moderate	All tooth surfaces affected; marked wear on biting surfaces; brown stains may be present
Severe	All tooth surfaces affected; discrete or confluent putting; brown staining present

Table 3: *The Dean Scale for dental fluorosis (American Dental Association, 2005a).*

The severity of dental fluorosis is dependent on many factors- when the overexposure to fluoride occurred during the enamel development, the duration of the overexposure, a person's weight, the degree of physical activity, nutritional factors, and bone growth (Alvarez, Rezende, Marocho, Alves, Celiberti, & Ciamponi, 2009). It is claimed that 40% of fluorosis cases are attributable to fluoridated water (Lewis & Banting, 1994); however, fluorosis is not unique to fluoridated communities (Alvarez, Rezende, Marocho, Alves, Celiberti, & Ciamponi, 2009). Based on research articles published between 1980 and 2000, it was found that non-fluoridated communities experienced an increase of fluorosis by 16-fold, while fluoridated communities experienced a 2-fold increase compared to fluorosis rates reported at the beginning of community water fluoridation in the 1940s (Khan, Moola, & Cleaton-Jones, 2005). Such findings are seen world-wide (Warren, Kanellis, & Levy, 1999). While Heller, Eklund, & Burt (1997) found that fluorosis prevalence increases with increasing fluoride levels, the number of fluorosis cases seems to increase in accordance with fluoride concentrations, regardless of a community's fluoridation status, as illustrated in Table 4. However, no discussion of the severity is provided.

Fluoride concentration	Percentage of children with fluorosis
0 – 0.3 ppm	13.5%
0.3 – 0.7 ppm	21.7%
0.7 – 1.2 ppm	29.9%
> 1.2 ppm	41.4%

Table 4: *Prevalence of fluorosis among children related to fluoride concentrations (Heller, Eklund, & Burt, 1997).*

The National Institute of Dental Research found that of US school children in 1986-1987, 22.3% had fluorosis based on the Dean scale. The Dean scale readings were as follows: 17.0% had very mild fluorosis, 4.0% had mild fluorosis, 1.0% had moderate fluorosis, and only 0.3% had severe fluorosis (American Dental Association, 2005a). Thus, the majority of fluorosis cases were of a degree that may be of little cosmetic significance.

The World Health Organization also identifies malnutrition, vitamin A and D deficiencies, and low-protein diets as being able to produce enamel effects similar to fluorosis (2001).

When discussing fluorosis prevalence and the risk of enamel fluorosis it is necessary to remember that non-fluoridated communities experience fluorosis, too, not all cases of fluorosis are cosmetically significant, enamel changes may not be from fluoride exposure but could be from other diet problems, and that fluorosis does not alter the functionality of the teeth.

- **Skeletal fluorosis**

Prolonged exposure to excessive concentrations of fluoride may lead to skeletal fluorosis, a bone disease marked by severe joint pain, stiffness, and changes in bone structure (World Health Organization, 2001). Skeletal fluorosis is very rare in the US, but affects millions worldwide. UNICEF has identified 25 countries that have endemic fluorosis (2005). The majority of research pertaining to skeletal fluorosis comes from populations like those in areas of India where water is naturally fluoridated up to 13.0 ppm (Hussain, Hussain, & Sharma, 2009). Skeletal fluorosis is also compounded by poor nutrition, which further contributes to poor bone health.

The fluoride concentrations associated with community water fluoridation are significantly lower than those found to contribute to skeletal fluorosis. While water in the US may naturally have fluoride levels of 4.0 ppm or more, EPA regulations prohibit community water supplies from containing fluoride concentrations over 4.0 ppm. Additionally, community water fluoridation takes necessary actions to defluoridate the water down to optimal levels of 0.7 – 1.2 ppm. While not all communities in the US participate in community water fluoridation, and the potential for consuming water that has excessive fluoride concentrations does exist, a 10-year comparison study of residents residing in Bartlett and Cameron, Texas, where fluoride levels are 8.0 ppm and 0.4 ppm, respectively, found that no clinically significant differences existed with respect to physiology and organ function (American Dental Association, 2005a).

It is very unlikely that fluoride levels found in community water fluoridated sources would cause skeletal fluorosis.

- **Cancer**

In 2006, *Cancer Causes and Controls* published research from Harvard University proclaiming that exposure to fluoridated water during childhood was associated with the incidence of osteosarcomas (bone tumors). The finding was only supported in males. Osteosarcomas are malignant tumors; the most common sub-type is conventional central osteosarcomas (National Cancer Institute, 2009). While osteosarcomas are the most common bone tumor in children, of all childhood cancers, it is very rare (The University of Texas MD Anderson Cancer Center, 2009), representing 0.2% of malignant tumors (Picci, 2007). Osteosarcomas can affect any bone in the body, but occur most often in the distal femur, proximal tibia, and the proximal humerus (National Cancer Institute, 2009). The exact cause of osteosarcoma is not know but risk factors for osteosarcomas are believed to be early exposure to high dose radiation and the following genetic conditions: Paget's disease, hereditary retinoblastoma, and Li-Fraumeni Syndrome (Troisi, et al., 2006). Genetic mutation is found to be the cause of osteosarcoma for 3-4% of children (Picci, 2007). The incidence of osteosarcoma is found to be greater in males, with a male to female ratio of 1.5 to 1 (Picci, 2007). Additionally, of persons less than 20 years of age, blacks have a higher incidence of osteosarcoma than whites, 5.2 cases per million compared to 4.6 cases per million (National Cancer Institute, 2009). Approximately 75% of cases occur in patients aged 15-25 years old (Picci, 2007).

While the Harvard study did demonstrate an association between fluoride consumption and osteosarcomas in males, the research design warrants caution, in that the researchers may be falsely, and inappropriately, associating one of the most common and pervasive exposures (fluoridated water) to a exceptionally rare health condition that effects a very small population. If osteosarcomas were the result of fluoridated water consumption, the researchers would have seen the same association in female patients, but they did not. Though osteosarcoma is more common in males, it is by no means exclusive to males. Similarly, we know that drinking water is a common activity that by no means is exclusively associated with only males. Additionally, the researchers were not able to discern how much fluoridated water any of the patients had consumed, nor were they able to discern how much fluoride had been absorbed into their bones. Therefore, their conclusion that fluoride consumption is associated with increased incidence in osteosarcomas is a weak conclusion based on their study results. Further studies are needed to confirm the results of this study.

Moreover, if fluoridated water is associated with osteosarcomas, as more communities initiate community water fluoridation, one would expect to see an increase in cases of osteosarcomas appearing in populations. Such a finding would be especially robust in countries that promote fluoridation, like the US, or countries that have water supplies with naturally occurring fluoride at elevated concentrations. However, in 2009, the *International Journal of Cancer* reported that after examining the Cancer Incidence in Five Continents, International Agency for Cancer Research database, that incidence rates of osteosarcoma among children and adolescents have remained similar across the world. Information from the National Cancer Institute (2008) further illustrates that the incidence rate of osteosarcoma in the US has remained fairly constant between 1985 and 2005, as shown in Figure 3.

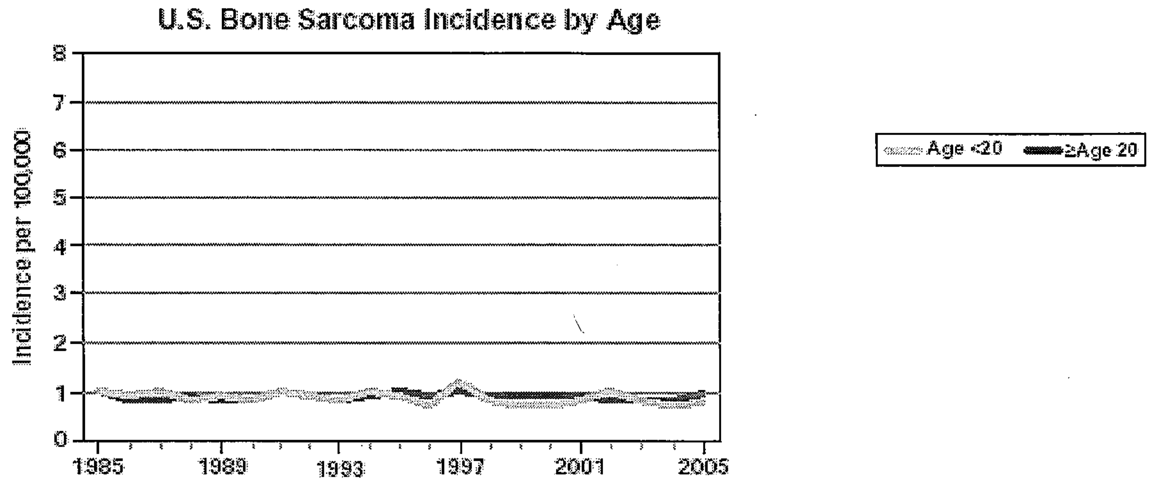

Figure 3: *Incidence rate of osteosarcoma by age in the US from 1985 to 2005 (National Cancer Institute, 2008).*

Research published prior to the Harvard study shows no statistical difference in cancer mortality and communities with fluoridated water (Mahoney, Nasca, Burnett, & Melius, 1991; Gelberg, Fitzgerald, Hwang, & Dubrow, 1995). Further research indicates that osteosarcoma incidence may be due to perinatal exposures and hormonal differences, which, again, disqualifies fluoridated water as being associated with osteosarcoma incidence rates (Troisi, et al., 2006).

In the aftermath of the Harvard study, the CDC issued a public statement regarding water fluoridation and osteosarcoma rates. The statement is available as Appendix III.

- **IQ**

In 2000 (Lu, Sun, Wu, Wang, Lu, Tianji) and 2003 (Xiang et al.) research from China was published demonstrating an association between exposure to high levels of fluoride and decreased intelligence quotients (IQ) in children. The fluoride levels found in the studied communities and the children's mean IQs are represented in Table 5. For reference, information on IQs is provided in Table 6. In both of the studies the fluoride levels found in the communities used for comparison do not include the concentrations used for community water fluoridation (again, 0.7 -1.2 ppm). Thus, while exposure to elevated fluoride levels may be a risk factor for lower IQ scores, there is no evidence from these studies suggesting that exposure to community fluoridated water is a risk for lower IQ.

Study 1	Mean fluoride in water	Children's mean IQ
High fluoride community	2.47 ± 0.79 ppm	92.02 ± 13.0
Low fluoride community	0.36 ± 0.15 ppm	100.41 ± 13.21
(Xiang et al., 2003)		
Study 2		
High fluoride community	3.15 ± 0.61 ppm	92.27 ± 20.45
Low fluoride community	0.37 ± 0.04 ppm	103.05 ± 13.86
(Lu., Sun, Wu, Wang, Lu, Tianji, 2000).		

Table 5: *Fluoride concentrations in water and children's IQs from studies conducted in China.*

IQ = (mental age/ chronological age) X 100; where score of 100 is true average	
IQ Score	**Classification**
0-25	Profound retardation
25-40	Severe retardation
40-55	Moderate retardation
55-70	Mild retardation
70-80	Borderline
80-90	Dull normal
90-110	Normal
110-120	Bright normal
120-130	Superior
130-200	Very superior

Table 6: *General information on intelligence quotients (Adapted from Gerrig & Zimbardo, 2005, pg. 293)*

Research from Mexico examining IQ scores in relation to exposure to fluoride and arsenic claims that for every 1.0 mg increase in fluoride exposure, a loss of 1.7 IQ points can be expected (Rocha-Amador, Navarro, Carrizales, Morales, & Calderon, 2007). While the research from Mexico did include a community whose fluoride levels were reflective of community water fluoridation – 0.8 ± 1.4 ppm, the study does not address arsenic-only exposure and a subsequent change in IQ score. Because of this, it is hard to distinguish what change in IQ is attributable to fluoride exposure, and what change in IQ is attributable to arsenic exposure. The study was further flawed in other areas. First, the researchers lumped children ranging in age from 6 to 10 years old together to determine the mean IQ of children in the specific communities. While these children are reflective of their communities, it is unjust to determine mean IQ scores from a population that is so varied in developmental maturity. The verbal and performance abilities of a 10 year old may be significantly more advanced than that of a 6 year old, which could easily skew the mean IQ results. Secondly, the researchers did not address IQs related to age groups, and thus it is hard to know if the children's IQ scores were on par with their own age group, or if significant deviations existed. Third, IQ tests were only administered in short form (abbreviated version), which could prove to be significant if statistically different scores were achieved on the longer form. Lastly, each child took the IQ test only once. No further IQ assessments, like a cross battery assessment, were administered to validate the findings, nor was the test re-administered to prove that the children exposed to arsenic and fluoride consistently demonstrated decreased intelligence.

Furthermore, when considering these intelligence studies from East Asia and from Mexico, or any region for that matter, it is necessary to weigh the cultural fairness of the intelligence tests used, as well as the relevancy to the culture. Tests that are culture fair are "equally appropriate for members of all cultures and comprises items that are equally fair to everyone" (Sternberg, 2004, p. 340). Culture relevant tests are those that demand using skills and knowledge sets relevant to the cultural experience of the test takers. In general, the tests used for IQ measurement are first designed in English with a frame more familiar to Western culture, and then translated into other languages. While the translation is verified to be correct, the content and procedures involved with a test may not be appropriate in terms of the test taker's social norms (Sternberg, 2004).

In conclusion, current research has not been able to identify an association between fluoride exposure from community water fluoridation and decreased intelligence.

- **Infant Formula**

In 2007 the CDC expressed concern regarding the use of fluoridated water to make infant formula. While the CDC considers mother's breast- milk to be the ideal nutrition source for babies, it has provided the following recommendation for making formula:

> Parents should follow the advice of the formula manufacturer and their child's doctor for the type of water appropriate for the formula they are using. Parents and caregivers of infants fed primarily with formula from concentrate who are concerned about the effect that mixing their infant's formula with fluoridated water may have in developing enamel fluorosis can lessen this exposure by mixing formula with low fluoride water most or all of the time. This may be tap water, if the public water system is not fluoridated (check with your local water utility). If tap water is fluoridated or has substantial natural fluoride (0.7 mg/L or higher), a parent may consider using a low-fluoride alternative water source. Bottled water known to be low in fluoride is labeled as purified, deionized, demineralized, distilled, or prepared by reverse osmosis. Most grocery stores sell these types of low-fluoride water. Ready to feed (no-mix) infant formula typically has little fluoride and may be preferred for use at least some of the time (2008a).

Community Water Fluoridation in Louisiana

On July 6, 2008, Governor Bobby Jindal signed into law SB312 Act 761. This act amended and reenacted R.S.40:5.11 (B) and (C) requiring public water systems with at least 5,000 connections to maintain optimal fluoride level ranges as established in rules and regulations. The bill also provides for funding, for reporting, for exemptions, and for related matters. A total of 26 public water systems were identified as falling under the provisions of Act 761. These systems have been notified and advised that the legislation has required them to produce a cost estimate by March 1, 2009 that includes the cost to update and change their facility's equipment to accommodate fluoridation as well as the purchase of the bulk fluoride supplies. Appendix IV identifies these public water systems and their initial cost estimates. The cost estimates are currently being reviewed to confirm accuracy. However, a precursory glance of the estimates has indicated that the estimates may in fact be excessive. As a point of comparison, Pinellas County, FL with a population in excess of 900,000 began fluoridating their water in June 2004 at an initial cost of $605,000 and an annual cost of $130,000 (Pinellas County, n.d.) The Texas Department of State Health Services reports system installation costs between $0.71 and $1.90 per capita with annual maintenance costs of $0.35 per capita (2000). These estimates are in alignment with CDC's estimated costs of water fluoridation using 2004 dollars. (See discussion of Cost Savings of Community Water Fluoridation)

Conclusion

Community water fluoridation in Louisiana is an appropriate dental caries prevention activity that has been proven to be safe and cost effective. Louisiana residents are at tremendous risk for poor oral health as a result of pervasive health disparities and social inequities. Louisiana would benefit immensely from further expansion of fluoridated water supplies.

References

Alvarez, J. A., Rezende, K. M., Marocho, S. M., Alves, F. B., Celiberti, P., & Ciamponi, A. L. (2009). Dental fluorosis: Exposure, prevention and management. *Medicina Oral, Patología Oral y Cirugía Bucal; 14*(2), 103-107.

American Dental Association. (2005a). *Fluoridation facts*. Chicago, IL: Author.

American Dental Association. (2005b). Tooth eruption. *Journal of the American Dental Association; 136*.

American Dental Association. (2009). Diabetes and your oral health. Retrieved on April 24, 2009, from http://www.ada.org/public/topics/diabetes_faq.asp .

American Water Works Association (2004). *AWWA M4 – Water Fluoridation Principles and Practices* Denver, CO: Author.

Bassin, E. B., Wypij, D., Davis, R. B., & Mittleman, M. A. (2006). Age-specific fluoride exposure in drinking water and osteosarcoma (United States). *Cancer Causes and Controls; 17*, 421-428.

Bauman, K. J., & Graf, N. K. (2003). Educational attainment: 2000. Census 2000 Brief. U.S. Department of Commerce Economics and Statistics Administration: U. S. Census Bureau.

Beverage Institute for Health and Wellness (2006). Consuming soft drinks does not raise risk for esophageal cancer. Atlanta, Georgia: Author.

Brunelle, J. A. & Carlos, J. P. (1990). Recent trends in dental caries in U.S. children and the effect of water fluoridation. *Journal of Dental Research; 69*(Special Issue), 723-727.

Buduneli, N., Baylas, H., Buduneli, E., Turkoglu, O., Kose, T., Dahlen, G. (2005). Periodontal infections and pre-term low birth weight: A caste-control study. *Journal of Clinical Periodontology; 32*, 174-181.

Centers for Disease Control. (1999a, April 2). Ten great public health achievements- United States, 1900-1999. *MMWR Weekly; 48* (12), 241-243.

Centers for Disease Control. (1999b, September 3). Water fluoridation and costs of Medicaid treatment for dental decay – Louisiana, 1995-1996. *MMWR Weekly; 48*(34), 753-757.

Centers for Disease Control (2001, July 11). Studies validate cost savings of community water fluoridation [Press release]. Atlanta, Georgia: Author.

Centers for Disease Control. (2005). *Water fluoridation: Nature's way to prevent tooth decay* [Brochure]. Atlanta, GA: Author.

Centers for Disease Control (2008a). Background: Infant Formula and the Risk for Enamel Fluorosis. Retrieved on May 1, 2009, from http://www.cdc.gov/FLUORIDATION/safety/infant_formula.htm .

Centers for Disease Control (2008b). CDC statement on the 2006 National Research Council (NRC) report on fluoride in drinking water. Atlanta, Georgia: Author

Centers for Disease Control (2008c). Water Fluoridation Reporting System Overiew. Atlanta, Georgia: Author.

Centers for Disease Control (2009). Oral health preventing cavities, gum disease, and tooth loss. *At a Glance*. Retrieved on April 23, 2009, from http://www.cdc.gov/nccdphp/publications/aag/doh.htm .

Clothier, B., Stringer, M., & Jeffcoat, M. K. (2007). Periodontal disease and pregnancy outcomes: Exposure, risk and intervention. *Best Practice and Research Clinical Obstetrics & Gynecology; 21*(3), 451-466.

Gelberg, K. H., Fitzgerald, E. F., Hwang, S., & Dubrow, R. (1995). Fluoride exposure and childhood osteosarcoma: A case-control study. *American Journal of Public Health; 85*(12), 1678-1683.

Gerrig, R. J., & Zimbardo, P. G. (2005). Psychology and Life (17th ed.). Boston: Pearson

Grembowski, D., Fiset, L., & Spadafora, A. (1992). How fluoridation affects adult dental caries. *Journal of the American Dental Association; 123*(2), 49-54.

Griffin, S. O., Gooch, B. F., Beltran, E., Sutherland, J. N., & Barsley, R. (2000). Dental services, costs, and factors associated with hospitalization for Medicaid-eligible children, Louisiana 1996-97. *Journal of Public Health Dentistry; 60*(1), 21-27.

Griffin, S. O., Gooch, B. F., Lockwood, S. A., & Tomar, S. L. (2001). Quantifying the diffused benefit from water fluoridation. *Community Dentistry and Oral Epidemiology; 29*(2), 120-129.

Griffin, S. O., Jones, K. J., & Tomar, S. L. (2001). An economic evaluation of community water fluoridation. *Journal of Public Health Dentistry; 61*(2), 78-86.

Heller, K. E., Eklund, S. A., & Burt, B. A. (1997). Dental caries and dental fluorosis at varying water fluoride concentrations. *Journal of Public Health Dentistry; 57*(3), 136-143.

Horton, A. L., Boggess, K. A., Moss, K. L., Jared, H. L., Beck, J., Offenbacher, S. (2008). Periodontal disease early in pregnancy is associated with maternal systemic inflammation among African American women. *Journal of Periodontology; 79*(7), 1127-1132.

Hussain, J., Hussain, I., Sharma, K. C. (2009). Fluoride and health hazards: Community Perception in a fluorotic area of central Rajasthan (India): An arid environment [Electronic version]. *Environmental Monitoring and Assessment.*

Khan, A., Moola, MH, & Cleaton-Jones, P. (2005). Global trends in dental fluorosis from 1980 to 2000: A systematic review. *Journal of the South African Dental Association; 60*(10), 418-421.

Lemke, C. W., Doherty, J. M., & Arra, M. C. (1970). Controlled fluoridation: The dental effects of discontinuation in Antigo, Wisconsin. *Journal of the American Dental Association; 80*(4), 782-786.

Lewis, D. W., & Banting, D. W. (1994). Water fluoridation: Current effectiveness and dental fluorosis. *Community Dental and Oral Epidemiology; 22*, 153-158.

Lu, Y., Sun, Z. R., Wu, L. N., Wang, X., Lu, W., Tianji, S. S. (2000). Effect of high-fluoride water on intelligence in children. *Fluoride; 33*(2), 74-78.

Mahoney, M. C., Nasca, P. C., Burnett, W. S., & Melius, J. M. (1991). Bone cancer incidence rates in New York State: Time trends and fluoridated drinking water. *American Journal of Public Health; 81*(4), 475-479.

Maryland Department of Health and Mental Hygiene Family Health Administration (n.d.) Heart disease and your oral health. Retrieved on April 23, 2009 from https://fha.maryland.gov/pdf/oralhealth/fact_sheets/Heart_Disease_and_Your_Oral_Health.pdf .

Mayo Clinic staff (n.d.) Oral health: A window to your overall health. Retrieved April 23, 2009 from http://www.mayoclinic.com/health/dental/DE00001 .

Minister of Health (2008). The effects of oral health on overall health. *It's Your Health.* Canada: Health Canada.

Mirabello, L., Troisi, R. J., & Savage, S. A. (2009). International osteosarcoma incidence patterns in children, middle aged, and elderly persons. *International Journal of Cancer; 125*(1), 229-234.

Mitchell-Lewis, D., Engebretson, S. P., Chen, J., Lamster, I. B., Papapanou, P. N. (2001). Periodontal infections and pre-term birth: Early findings from a cohort of young minority women in New York. *European Journal of Oral Science; 109*, 34-39.

National Cancer Institute. (2008). A snapshot of sarcoma. Rockville, MD: Author.

National Cancer Institute. (2009). Osteosarcoma and malignant fibrous histiocytoma of bone treatment. *PDQ Cancer Information Summaries*. Rockville, MD: Author.

Office of Disease Prevention and Health Promotion (2005). Oral health. In *Healthy People 2010* (sect.21). Retrieved April 23, 2009, from http://www.healthypeople.gov

Petersen, P. E. (2008). The world oral health report 2003: Continuous improvement of oral health in the 21st century- the approach of the WHO Global Oral Health Programme. *Community Dentistry and Oral Epidemiology; 31*(S1), 3-24.

Picci, P. (2007). Osteosarcoma [Electronic version]. *Orphanet Journal of Rare Diseases; 2*(6).

Pinellas County Utilities (n.d.). Fluoridated water in Pinellas county what's in it for you. Retrieve May 1, 2009, from http://www.pinellascounty.org/Utilities/fluoridation.htm .

Ringelberg, M. L., Allen, S. J., & Brown, L. J. (1992). Cost of fluoridation: 44 Florida communities. *Journal of Public Health Dentistry; 52*(2), 75-80.

Rocha-Amador, D., Navarro, M. E., Carrizales, L., Morales, R., Calderon, J. (2007). Decreased intelligence in children and exposure to fluoride and arsenic in drinking water. *Cad. Saude Publica; 23*(4S), 579-587.

State of Louisiana Department of Health and Hospitals (2007). *2006 Louisiana Health Report Card*. Louisiana: Author.

State of Louisiana Department of Health and Hospitals (2009a). HPSAs. Retrieved June 03, 2009, from http://www.dhh.louisiana.gov/offices/miscdocs/docs-88/hpsa/dental.pdf.

State of Louisiana Department of Health and Hospitals (2009b, March 25). DHH starts week-long effort to reach state's uninsured [Press release]. Baton Rouge, LA: Author.

State of Texas Department of State Health Services (2000). Water fluoridation costs in Texas: Texas Health Steps (EPSDT-Medicaid). Retrieved May 1, 2009, from http://www.dshs.state.tx.us/dental/pdf/fluoridation.pdf .

Stephen, K. W., McCall, D. R., & Tullis, T. I. (1987). Caries prevalence in northern Scotland before, and 5 years after, water defluoridation. *British Dental Journal*; *163*(10), 324-326.

Szpunar, S. M., & Burt, B. A. (1988). Dental caries, fluorosis, and fluoride exposure in Michigan schoolchildren. *Journal of Dental Research; 67*(5), 802-806.

Sternberg, R. J. (2004). *Psychology* (4th ed.). Belmont, CA: Thomson Wadsworth.

The University of Texas MD Anderson Cancer Center (2009). Children's cancer hospital disease and treatment information. Retrieved March 31, 2009, from http://www.mdanderson.org/children .

Troisi, R., Masters, M. N., Joshipura, K., Douglass, C., Cole, B. F., Hoover, R. N., et al. (2006). Perinatal factors, growth and development, and osteosarcoma risk. *British Journal of Cancer; 95*(11), 1603-1607.

Truman, B. I., Gooch, B. F., Sulemana, I., Gift, H. C., Horowitz, A. M., et al. (2002). Reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. *American Journal of Preventative Medicine; 23*(1S), 21-54.

Tsutsui, A., Yagi, M., & Horowitz, A. M. (2000). The prevalence of dental caries and fluorosis in Japanese communities with up to 1.4 ppm of naturally occurring fluoride. *Journal of Public Health Dentistry; 60*(3), 147-153.

UNICEF (2005). Common water and sanitation-related diseases. In *Water, Santitation, and Hygiene*. Retrieved April 29, 2009, from http://www.unicef.org/wash/index_wes_related.html .

U.S. Department of Health and Human Services (2005). Healthy people 2010: The cornerstone for prevention. Rockville, MD: Author.

Warren, J. J., Kanellis, M. J., Levy, S. M. (1999). Fluorosis of the primary dentition: What does it mean for permanent teeth?. *Journal of the American Dental Association*; *130*(3), 347-356.

Way, R. M. (1964). The effect on dental caries of a change from a naturally fluoridated to a fluoride-free communal water. *Journal of Dentistry for Children; 31*, 151-157.

Weinstein, L. H., & Davison, A. W. (2004). *Fluorides in the Environment*. CABI Publishing.

World Health Organization (2001). Water- related diseases. Retrieved April 28, 2009, from http://www.who.int/water_sanitation_health/diseases/fluorosis/en/ .

Xiang, Q., Liang, Y., Chen, L., Wang, C., Chen, B., Chen, X., et al. (2003). Effect of fluoride in drinking water on children's intelligence. *Fluoride; 36*(2), 84-94.

APPENDIX I

Health People 2010 Focus 21: Oral Health

Goal: Prevent and control oral and craniofacial diseases, conditions, and injuries and improve access to related services	
Objective	
21-1	**Reduce the proportion of children and adolescents who have dental caries experience in their primary and permanent teeth**
21- 1a	Reduce the proportion of young children with dental caries in their primary teeth from 18% to 11%
21- 1b	Reduce the proportion of children with dental caries experience in their primary dentition from 52% to 42%
21- 1c	Reduce the proportion of adolescents with dental caries experience in their permanent teeth from 61% to 51%
21-2	**Reduce the proportion of children, adolescents, and adults with untreated dental decay**
21- 2a	Reduce the proportion of young children with untreated dental decay in their primary teeth from 16% to 9%
21- 2b	Reduce the proportion of children with untreated dental decay in primary and permanent teeth from 29% to 21%.
21- 2c	Reduce the proportion of adolescents with untreated dental decay in their permanent teeth from 20% to 15%
21- 2d	Reduce the proportion of adults with untreated dental decay from 27% to 15%
21-3	**Increase the proportion of adults who have never had a permanent tooth extracted because of dental caries or periodontal disease from 31% to 42%**
21-4	**Reduce the proportion of older adults who have had all their natural teeth extracted from 26% to 20%**
21-5	**Reduce periodontal disease**
21- 5a	Reduce gingivitis in adults from 48% to 41%
21- 5b	Reduce destructive periodontal disease in adults from 22% to 14%
21-6	**Increase the proportion of oral and pharyngeal cancers detected at the earliest stage from 35% to 50%**
21-7	**Increase the proportion of adults who, in the past 12 months, report having had an examination to detect oral and pharyngeal cancers from 13% to 20%**
21-8	**Increase the proportion of children who have received dental sealants on their molar teeth**
21- 8a	Increase the proportion of children aged 8 years old who have received dental sealants from 23% to 50%
21- 8b	Increase the proportion of adolescents aged 14 years old who have received dental sealants from 15% to 50%
21-9	**Increase the proportion of the US population served by community water systems with optimally fluoridated water from 62% to 75%**

21-10	**Increase the proportion of children and adults who use the oral health care system each year from 44% to 56%**
21-11	**Increase the proportion of long-term care residents who use the oral health care system each year from 19% to 25%.**
21-12	**Increase the proportion of low-income children and adolescents who received any preventative dental service during the year from 20% from 57%.**
21-13	**(Developmental) Increase the proportion of school-based health centers with an oral health component.**
21-14	**Increase the proportion of local health departments and community-based health centers, including community, migrant, and homeless health centers, that have an oral health component from 34% to 75%.**
21-15	**Increase the number of States and the District of Columbia that have a system for recording and referring infants and children with cleft lips, cleft palates, and other craniofacial anomalies to craniofacial anomaly rehabilitative teams from 23 States and the District of Columbia with systems to total coverage.**
21-16	**Increase the number of States and the District of Columbia that have an oral and craniofacial health surveillance system from none to all.**
21-17	**(Developmental) Increase the number of Tribal, State (including the District of Columbia), and local health agencies that serve jurisdictions of 250,000 or more persons that have in place an effective public dental health program directed by a dental professional with public health training.**

Adapted from Office of Disease Prevention and Health Promotion, 2005.

APPENDIX II

American Dental Association. (2005a). *Fluoridation facts*. Chicago, IL: Author.

http://www.ada.org/public/topics/fluoride/facts/fluoridation_facts.pdf

APPENDIX III

CDC Statement on Water Fluoridation and Osteosarcoma

Osteosarcoma is a type of rare bone cancer. About 400 children and adolescents in the United States are diagnosed each year, approximately 250 of whom are males. An observed association between exposure to fluoride in drinking water and the incidence (new cases) of osteosarcoma in young males has been reported in a paper entitled Age-specific Fluoride Exposure in Drinking Water and Osteosarcoma (United States) (Bassin et al., 2006). No apparent association was observed in females. This research, which the author describes as an exploratory analysis, adds to the scientific knowledge base on this topic. The author acknowledges that this study has limitations and further research is required to confirm or refute this observation.

This paper is based on the analysis of an initial set of cases from a 15-year effort to study fluoride and osteosarcoma by the Harvard School of Dental Medicine and collaborating organizations. The principal investigator for the overall study cautions against over interpreting or generalizing the results of the Bassin analysis, stressing that preliminary analysis of a second set of cases does not appear to replicate the findings (Douglass et al., 2006). Publications from the forthcoming analyses are expected to provide further information as to whether and to what extent an association may exist between osteosarcoma and exposure to fluoride.

A number of studies regarding water fluoridation and osteosarcoma have been published in the past. At this time, the weight of the scientific evidence, as assessed by independent committees of experts, comprehensive systematic reviews, and review of the findings of individual studies does not support an association between water fluoridated at levels optimal for oral health and the risk for cancer, including osteosarcoma. In a report issued in March 2006, Fluoride in Drinking Water: A Scientific Review of EPA's Standard, the National Research Council (NRC, 2006) considered all available evidence on fluoride and osteosarcoma, including pre-publication data from the analysis by Dr. Bassin. The NRC Committee found the overall evidence on osteosarcoma to be tentative and mixed, and no recommendations were made related to this health concern for revising current allowable fluoride levels in drinking water. The report stated that the results of the larger Harvard study, once published, may provide an important and useful addition to the weight of scientific evidence regarding this condition.

CDC's mission includes monitoring health, detecting and investigating health problems, developing and advocating for sound public health policies, implementing prevention strategies, promoting healthy behaviors, and fostering safe and healthful environments. The overriding goal and concern is protecting the health and well being of the public. CDC continually monitors and evaluates scientific information on fluoridation as part of its responsibility for public health assurance and protection. CDC, along with experts in the scientific community, will review published studies when they become available, will continue to monitor other scientific developments related to water fluoridation, and will provide guidance and recommendations about fluoride to the public.

CDC continues to strongly support community water fluoridation as a safe and effective public health measure to prevent and control tooth decay and to improve overall health. Water fluoridation benefits people of all ages and socioeconomic groups, including those difficult to reach through other public health programs and private dental care. CDC has recognized community water fluoridation as one of 10 great public health achievements of the 20th century. Those wishing to learn more about fluoridation can find CDC's Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States and other information at www.cdc.gov/oralhealth.

References

Bassin EB, Wypij D, Davis RB, Mittleman MA. Age-specific fluoride exposure in drinking water and osteosarcoma (United States). Cancer Causes and Control 2006;17:421–428.

Douglass CW, Joshipura K. Caution needed in fluoride and osteosarcoma study. Cancer Causes and Control 2006;17:481–482.

National Research Council Committee on Fluoride in Drinking Water. Fluoride in drinking water: A scientific review of EPA's standards. Washington, D.C: The National Academies Press, 2006.

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Department of Health and Human Services

APPENDIX IV

WATER SYSTEM NAME	SERVICE CONNECTIONS	POPULATION	SOURCE	SURFACE WATER INTAKES	WELLS	PARISH	COST ESTIMATE
ST BERNARD PAR WATERWORK	11261	33000	SW	1	0	ST BERNARD	39,524
SOUTH BEAUREGARD WATER SYSTEM	5420	17886	GW		9	BEAUREGARD	616,000
BAKER, CITY OF	5271	14495	GW		4	EAST BATON ROUGE	0
BATON ROUGE WATER COMPANY	96318	385272	GW		64	EAST BATON ROUGE	4,689,016
PARISH WATER COMPANY	35172	123130	GW		29	EAST BATON ROUGE	
ZACHARY, CITY OF	5645	16257	GW		4	EAST BATON ROUGE	134,500
NEW IBERIA WATER SYSTEM (LAWCO)	18364	49092	GW		9	IBERIA	462,080
LAFAYETTE UTILITIES WATER SYSTEM	47000	141000	GW		19	LAFAYETTE	652,400
RUSTON WATER SYSTEM	8391	20667	GW		9	LINCOLN	
DENHAM SPRINGS, CITY OF*	7218	28872	GW		5	LIVINGSTON	
WARD II WATER DISTRICT	14947	44841	GW		14	LIVINGSTON	
BASTROP WATER SYSTEM	6730	20190	GW		6	MOREHOUSE	82,817
NATCHITOCHES WATER SYSTEM	8959	30000	SW	1		NATCHITOCHES	69,444
MONROE WATER SYSTEM	17524	52572	SW	2		OUACHITA	186,900
WEST MONROE WATER SYSTEM*	5226	15678	GW		6	OUACHITA	
ALEXANDRIA CITY OF	17375	58396	GW		51	RAPIDES	460,300
PINEVILLE CITY OF	6597	20315	GW		10	RAPIDES	0
RAPIDES PARISH WATERWORKS DISTRICT NO 3	6500	19500	SW	1	6	RAPIDES	468,856
OPELOUSAS CITY OF WATER SYSTEM	7850	24150	GW		8	ST LANDRY	144,716
EUNICE WATER SYSTEM (LAWCO)	5244	15732	GW		4	ST LANDRY	
MORGAN CITY WATER SYSTEM	6300	12703	SW	2		ST MARY	64,000
SLIDELL WATER SUPPLY	9653	38612	GW		4	ST TAMMANY	110,994
TANGIPAHOA PARISH WATER DISTRICT	12431	29988	GW		8	TANGIPAHOA	
ABBEVILLE CITY OF WATER SYSTEM*	5150	15450	GW		2	VERMILION	
BOGALUSA, CITY OF	5726	14000	GW		7	WASHINGTON	161,400
MINDEN WATER SYSTEM	5650	16950	GW		10	WEBSTER	490,000
TOTALS	381,922	1,258,748		7	288		8,832,947

*Items submitted, but no cost estimate

GW = Ground Water
SW = Surface Water