

Classification  
And Appraisal  
of Objections  
to Fluoridation

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## FOREWORD

Because of the demand for factual information regarding fluoridation by so many disturbed citizens, by frustrated members of departments of health, and by the formally expressed desire of the Dental Health Section of the American Public Health Association, this report was developed at the School of Public Health of the University of Michigan during the school year 1956-57. It began as an assignment to 20 students of dental public health in the fall semester of 1956. They were asked to assemble all of the objections that they could find to the fluoridation of public supplies of water and then to classify these objections in an orderly outline. The result of the assignment was the index on the following pages.

Later in the fall semester, each student was assigned a related group of objections, requested to search the literature on fluoridation carefully, and then asked to write a brief, critical appraisal of the validity of each objection in his assigned group. During the spring semester, Kenneth R. Elwell, B.S.D., D.D.S., M.P.H., Colonel, U. S. Air Force (D.C.), continued this assignment by thoroughly checking the accuracy of each student's report and references and by searching the literature for additional scientific findings that had been missed. His task, which resulted in this report, required several hundred hours of careful and painstaking work in the libraries of the University of Michigan.

Miss Rose-Grace Faucher, PhB, AMLS, Associate Divisional Librarian, assisted considerably in securing references and the writer of this foreword served as a consultant. The list of students of dental public health, who worked with Colonel Elwell during the fall semester, follows:

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It will be noted in the index that eight general areas of objections, including one unclassified group, have been explored. The references cited follow each group of appraisals and separate bibliographies of references have been submitted for Sections A and B of Part I, "Toxicity for Animals and Human Beings." Use of the detailed index should make the location of specific information quite easy.

Kenneth A. Easlick

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2. There is a lack of means of dealing with the objections and questions of the public . .	50	4. Adding fluoride to water is a big nuisance for the personnel of waterworks . . . . .	51
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7. Multiple sources of water make an impossible situation for the addition of fluoride to a communal supply of water . . . . .	51	11. Fluoridation of water will cause bursting of the water mains . . . . .	52
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2. The topical application of fluoride to the teeth is equally as efficient in reducing the incidence of dental caries as the consumption of fluorides in drinking water and presents fewer problems . . . . .	54	5. Drinking water is not a suitable vehicle for administering fluorides . . . . .	55
3. Individuals may receive the full benefits of fluorides by using toothpaste or mouthwashes containing any one of several of these compounds . . . . .	54	6. Fluorides, prepared in solution by the druggist, may be added to one's own drinking water. This method of administering fluorides is better than fluoridation of the communal water supply and permits the use of "drug"-grade fluorides . . . . .	55
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7. Fluoridation should be put to a referendum for all people in the city to decide . . . . .	60	17. If it is decided by plebiscite to fluoridate the water, an alternative source of water must be made available for those who do not wish to drink fluoridated water . . . . .	63
8. The legal right to fluoridate drinking water without the consent of the people has not been established . . . . .	60	18. Fluoridation of water does not adhere to	
9. Fluoridation is another step in socializing the United States . . . . .	60		
10. Fluoridation deprives people of their personal liberties and violates the freedom of personal care of one's own body . . . . .	60		
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the ten standards set up by the Nuremburg War Crimes Tribunal for experimentation on the lives of human beings . . . . .	63	in the home . . . . .	63
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2. Fluoridation benefits children only . . . . .	66	9. The statistical evidence alleged to support fluoridation's hypothesis is invalid because biased dental examiners and improper statistical methods were used . . . . .	68
3. Artificial fluoridation may not produce the same results as do natural fluorides in the water . . . . .	67	10. The best teeth are found in non-fluoride areas . . . . .	69
4. Fluoridation has not been recommended by the American Water Works Association . . . . .	67	11. The so-called benefits of fluorides in areas of the Southwest are not due to the fluorides in the water but to the greater amount of minerals in the soil . . . . .	70
5. Fluoridation is still in the experimental stage, and some experiments have produced contradictory results, e.g., experiments on human beings at Brantford, Ontario, show twice as much dental decay after a few years of fluoridation . . . . .	67	12. The reported beneficial effects of fluorides may be due to some other factor, such as presence of magnesium or calcium in water . . . . .	70
6. No one is sure that fluorine is the element responsible for lower rates of dental decay. . . . .	67	13. Evidence supporting the value of fluoridation is presumptive, as is all epidemiological evidence . . . . .	71
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1. Fluoridation is being promoted for the purpose of selling equipment and chemicals . . . . .	74	people would demand it . . . . .	77
2. Fluoridation is being promoted to provide a profitable method of disposing of cryolite saturated with fluorine, a waste product of the aluminum industry . . . . .	74	11. Tooth decay can be reduced sufficiently by the restriction of sugars, therefore, fluoridation is not needed . . . . .	77
3. Fluorides cause water to have an objectionable taste and smell and change the taste of coffee, tea, and foods . . . . .	75	12. Fluorine has been outlawed by the United Nations for use in warfare . . . . .	78
4. Pro-fluoridationists are using the "big lie" technic . . . . .	75	13. It is definitely not the duty of water companies to practice preventive medicine or dentistry . . . . .	78
5. Fluorides in water cause women difficulty in the management of their hair . . . . .	76	14. If a municipality can afford to finance fluoridation, the funds for the purpose could be used more advantageously in providing dental care for the indigent children . . . . .	78
6. In response to the appeal of fluoridation, dentistry's great nutritional emphasis was lost . . . . .	76	15. Many persons who have opposed fluoridation have been tricked, ridiculed and suppressed and are afraid to give testimony . . . . .	79
7. Any sensible person knows that the way to improve dental health is to give children plenty of milk and a balanced diet, not fluorides . . . . .	76	16. All persons working in health departments are in a chain of command and must take orders from the officials of the U. S. Public Health Service . . . . .	79
8. Dentists have evaluated fluoridation programs and made statements about general health; only a physician should make statements about general health and non-dental diseases . . . . .	76	17. Proponents of fluoridation have not considered the effect of cosmic rays on fluoridated water . . . . .	80
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## CLASSIFICATION AND APPRAISAL OF OBJECTIONS TO FLUORIDATION

### I. TOXICITY TO MAN AND ANIMALS

#### A. Disorders alleged to be caused or made worse by the consumption of fluoridated water:

1. **OBJECTION:** Fluorides cause or accelerate the growth of cancer.

**APPRAISAL:** The allegation that fluorides cause or accelerate the growth of cancer probably is based on the wide publicity given the results of an experiment with cancer in mice conducted by Alfred Taylor, a biochemist at the University of Texas, in 1951. His results indicated that mammary tumors were produced earlier than usual in groups of mice susceptible to mammary cancer. However, a report in the *Texas Dental Journal*<sup>1</sup> in 1951, revealed, while these animals were given water containing 0.44 p.p.m. (parts per million) fluorine, that they also were fed a diet of dog chow which, unintentionally, contained an additional 42 p.p.m. fluorine. Therefore, the control-mice received 42 p.p.m. while the experimental animals received 42.44 p.p.m. It is apparent that no difference in the incidence of tumors could be attributed to such a small increase. Moreover, the mice used were inbred for susceptibility to mammary tumors. Approximately 96-100 per cent of these mice eventually succumb to mammary tumors regardless of the diet or water.

There is no evidence that cancer of the breast in human beings relates to fluorides in drinking water. On the contrary, in New England, where water supplies contain little or no fluoride, the prevalence of cancer of the breast averages only 17.0 per 100,000. In Texas, despite the presence of up to 5.0 p.p.m. of fluorides in drinking waters the average rate for cancer of the breast is only 7.0 per 100,000. At any rate, there is no evidence to indicate that the risk of death by cancer is increased by drinking fluoridated water.<sup>2</sup>

Tannenbaum and Silverstone<sup>3</sup> found that the incidence of tumors decreased in mice fed a diet which contained 900 p.p.m. of sodium fluoride. The decrease was presumed to be related to a marked retardation of growth rather than to the direct effect of the fluorides.

In a scientific study<sup>4</sup> of 32 pairs of cities in 16 states, the rates of death were compared in cities using water containing 0.25 p.p.m. or less of fluorides with cities whose waters contained 0.7 p.p.m. or more of fluorides. Evaluation of the data revealed no

statistically significant difference in the rates of death either from "all causes," or from five specific diseases, including *cancer*, heart disease, intracranial lesions, nephritis or cirrhosis of the liver.

Dr. Charles S. Cameron, President of the American Cancer Society, in a letter to Dr. Tom M. Oliver of Waco, Texas, stated<sup>5</sup> that "No valid scientific evidence known to the Society supports a causative relationship of fluorine (specifically in amounts used in water fluoridation for the purpose of dental caries prophylaxis) to cancer. On the contrary, such epidemiological and laboratory experimental data as are available indicate no such relationship."

Analyses of vital statistics provide facts on the rates for cancer. The records of bureaus of vital statistics indicate that rates are higher in states where the waters are fluoride-free than in states where there are many areas of water with fluorides present. There is no evidence to conclude, however, that lower rates for cancer are produced by the fluorides in the water.<sup>1,6</sup>

Analysis of the rates of death from cancer and cardio-vascular disease were conducted as a part of the studies<sup>7</sup> of fluoridation in the cities of Newburgh and Kingston, New York. The analyses of these data from 1942 through 1954 showed no consistent pattern from year to year. However, it was clear that there was no increase in deaths from these causes during the period of fluoridation of the water. The differences in distribution by ages were too small to affect the rates significantly.

2. Diseases of the digestive organs and conditions related to interference with the normal function of the digestive system:

- a. **OBJECTIONS:** Fluoridated water causes conditions or diseases of the digestive tract which include (1) gastric or duodenal ulcers, (2) colitis, (3) failure of synthesis of vitamin B, (4) failure of absorption of vitamins B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, and C, (5) nausea and vomiting, (6) diarrhea, and (7) constipation.

**APPRAISAL:** A comprehensive review of the literature on fluoridation reveals no evidence that any of the conditions or diseases are caused by fluorides, used in concentrations recommended for communal supplies of water.

Cox and Hodge<sup>8</sup> have reviewed the literature relating to toxicity of fluorides. Their conclusions indicate that the minimum lethal dose is approximately 50 milligrams per kilogram of body-weight. Their opinion that four grams is the minimum amount of sodium fluoride known to have caused death of an adult has been accepted widely. Black, Kleiner and Bolker<sup>9</sup> have stated that oral doses of 20 to 50 milligrams of sodium fluoride given four times a day to children 3½ to 6 years of age, or 80 milligrams given four times a day to adults, were not toxic. These human experiments indicate that there is a wide margin of safety in drinking water which contains the concentrations of fluoride recommended for drinking water.

A well-controlled, 10-year epidemiological study was conducted by Leone and others,<sup>10</sup> from 1943 to 1953, to determine the systemic effects of human ingestion of excessive fluorides. Bartlett, Texas, with water containing 8.0 p.p.m. of fluoride, was the area studied and Cameron, Texas, with about 0.4 p.p.m. fluoride in its water, served as the control. Exhaustive analysis of all data led to the conclusion that "medical characteristics of the two groups do not differ more than would be expected of two comparable towns with or without an excess of fluoride in the water supply." It is significant that no unusual conditions of the digestive tract were revealed through the thorough medical examinations completed by these investigators.

Medical examinations of children were made as a part of the routine study of fluoridation in Newburgh and Kingston, New York. Children in Kingston used fluoride-free water, whereas Newburgh children drank water fluoridated to 1.2 p.p.m. No differences of medical significance were found between the two groups of children. Therefore, substantial evidence was added by this scientific study to demonstrate the safety of fluoridation. Again, it is emphasized that no findings of diseases or unusual conditions of the digestive tract were revealed, even though this thoroughly scientific study covered a period in excess of 10 years and included complete physical, laboratory and radiographic examinations.

- b. **OBJECTION:** Fluoridated water causes disorders of the liver, such as cirrhosis, degeneration, or hepatitis.

**APPRAISAL:** A search of the scientific literature reveals no evidence to indicate that drinking water which contains 1.0 to 1.5 p.p.m. of fluoride has any cumulative or harmful effects upon the liver. On the

contrary, available scientific studies, some of which cover periods in excess of ten years,<sup>1,4,10</sup> have demonstrated conclusively that drinking water which contains about 1 p.p.m. of fluoride produces no systemic diseases or malfunctions.

- c. **OBJECTION:** Fluoridated water interferes with normal enzymatic function.

**APPRAISAL:** It is true that a high concentration of fluoride may inhibit certain enzymatic processes. However, there is no evidence that the ingestion of drinking water containing about 1 p.p.m. fluoride will produce a concentration of fluoride in any tissue of the body that will affect adversely the enzymatic systems of that tissue.<sup>11</sup>

The ability of the kidneys to excrete fluoride and the capacity of the bones to store fluoride without injury provide mechanisms whereby the concentration of fluoride in the blood is kept at an extremely low level. The Newburgh-Rochester studies<sup>11</sup> of blood-fluoride concentrations determined the maximum concentration to be 0.1 p.p.m. in each population. Concentration in Newburgh, which had 1.1 p.p.m. fluorides in its waters, exhibited an average blood level of 4.0 micrograms per 100 ml of blood. When fluorides enter the body, the fluoride in the blood rises and falls very rapidly.<sup>12</sup> This human physiologic mechanism aids in the prevention of an accumulation of the fluoride which would be required to interfere with enzymatic processes.<sup>11</sup>

There has been no demonstration that fluoride ions in a concentration of 1 p.p.m. in water will affect adversely any enzyme used in a fermentation or any other industrial process.<sup>13</sup>

3. Diseases or disorders of the kidneys and urinary systems such as nephritis, nephrosis, renal insufficiency, and uremia.

**OBJECTION:** Fluorides cause or aggravate diseases or disorders of the kidneys, such as nephritis, nephrosis, renal insufficiency, and uremia.

**APPRAISAL:** The amount of fluorine ingested daily when drinking fluoridated water containing 1 p.p.m. fluorine has been estimated to range between 0.5 to 1.0 milligrams.<sup>14</sup> When the amount of fluorine taken into the human system per day does not exceed 4.0 to 5.0 mg., its elimination is virtually complete through the urine, fecal excretion and perspiration.<sup>15</sup> Thus it is obvious that the body is capable of eliminating easily the small amounts that are ingested in drinking waters which contain

about 1 p.p.m. of fluoride.<sup>11,15</sup> It has been stated<sup>16</sup> by leading authorities on human nutrition that "it is necessary to take into the human system from five to 10 grams in one dose in order to cause fatal poisoning. Thus, for any person to become poisoned from drinking fluoridated water at one part per million, that person would have to drink at least fifty bathtubs full of water. Long before, the person would die of water intoxication or drowning."

Experiments were conducted by Smith, Gardner and Hodge<sup>17</sup> in which rabbits were given near-fatal doses of uranium which produced severe damage of the kidneys. These rabbits, and a group of untreated control-rabbits then were given water containing 15 p.p.m. of fluoride for 42 days. The daily intake and excretion of each rabbit were measured. Results showed that the rabbits with damaged kidneys and the controls had excreted almost identical amounts of fluorides. No significant differences were found between the groups of rabbits with regard to renal efficiency in eliminating fluorides, even in the presence of a severe chemical nephritis.

Search of the scientific literature reveals no evidence that diseases of the kidneys is caused or aggravated by water fluoridated to a concentration of approximately 1.0 p.p.m. The Department of Health of Illinois<sup>18</sup> specifically found no increase in risk of death by nephritis due to fluoridated water. A review of the vital statistics of the departments of health of Illinois and Wisconsin has detected no significant differences in the data on nephritis obtained from cities with varying amounts of fluoride in their public water supplies.<sup>4,18,19</sup>

Heyroth,<sup>20</sup> after an extensive review of the literature dealing with metabolism and the toxicology of fluoride, concluded: "No evidence exists that waterborne fluoride has been a cause of nephritis."

An important investigation in 1956 by Schlesinger, Overton and Chase,<sup>21</sup> concerned possible minimal irritative effects on the kidneys of fluoridated water. Two groups of 12-year-old boys in Kingston and Newburgh were studied and the conclusions were reached that there were no significant differences between the two groups in the quantitative excretion of albumin, red blood cells and casts. The study disclosed no evidence of any irritative effect on the kidneys.<sup>22</sup>

#### 4. Diseases or disorders of the respiratory system, including pulmonary tuberculosis, asthma, rhinitis, sinusitis, bronchitis, and respiratory failure.

There are only a few references in the scientific literature which concern fluorides and the respiratory system. It is known that inhalation of fluorides as dusts or vapors caused

fluorosis among 78 Danish miners of cryolite. Mølter and Gudjonsson,<sup>23</sup> using radiographs of chests, found that 30 of the workmen exhibited marked increased densities of their spinal columns, pelvis and ribs. Two of the men died from intercurrent diseases. It is of interest to note that estimates of the probable amounts of fluorides inhaled daily by these men ranged from 0.2 to 0.35 mg. per kg. of body weight. Yet in neither man did the organs exhibit any histopathologic changes attributable to fluorides.

Animal experiments were reported by Heyroth<sup>20</sup> in which two dogs were fed daily diets containing 3.0 and 5.0 mg. per kg. of weight. One dog received cryolite (sodium aluminum fluoride) and the other dog received sodium fluoride; a littermate was used as a control. The experiment continued for five years and five months and ended with the death of the control. Increased amounts of fluorides were noted in the bones of the dog given sodium fluoride and also, that the lungs contained 1.77 and the kidneys 3.01 mg. per kg. of body weight. Nevertheless, no noteworthy histopathologic changes were found in the organs and the bones exhibited no striking abnormalities.

A study by Hough and others<sup>24</sup> concerned the rates of respiratory diseases for workmen who inhaled sodium fluoride at openhearth steel furnaces. It was concluded that respiratory diseases, which caused absences of eight days or longer, were lower in the steel plant where fluoride was a hazard than in another plant where the danger did not exist.

Roholm<sup>25</sup> reported that cryolite workers had fewer sick days ascribable to diseases of the respiratory system than did the workers in certain other Danish industries.

The lower incidence of respiratory disease in the plants discussed in the Hough<sup>24</sup> and Roholm<sup>25</sup> studies should be ascribed to factors other than the benefits derived from low concentrations of fluorides. This conclusion is in agreement with data secured in a study by Anna Baetjer of the effects of air-pollutants on acute infectious respiratory diseases. No evidence was obtained that chronic exposures to low concentrations of chemical contaminants in air affect susceptibility to acute respiratory infections.<sup>26</sup>

It may be concluded from a detailed review of the literature that there is no evidence to indicate that fluorides in drinking waters are related in any way to diseases of the respiratory system.

#### 5. Diseases of the circulatory system

a. OBJECTION: Fluorides are used in industry as hardening agents and, therefore, fluorides will cause hardening of the arteries.

APPRAISAL: This conclusion has been

based on a lack of understanding of the chemical, pharmacological and physiological actions of fluorides.<sup>27</sup> Confusion may have arisen over the custom of using the word "hardening" in the sense that it applied to the physico-chemical processes of industry. This use of the word is entirely different from "hardening," as the term is applied to the physiological action of arteriosclerosis in which the arterial walls become calcified.<sup>28,13</sup>

It should be remembered, while the specific cause of arteriosclerosis is not known, that there are some factors known to contribute to the hardening of arteries. These factors were known prior to the practice of fluoridating supplies of water and were found to be completely independent of fluoridation. Actually, the development of arteriosclerosis is a part of the natural process of aging. Therefore, if the average span of life has increased, the obvious sequence is an increase in the conditions incident to the process of aging independent of any other factor.<sup>29</sup>

- b. **OBJECTION:** Occurrence of varicose veins has been associated with endemic fluorosis.

**APPRAISAL:** The incidence of endemic fluorosis is governed by the protracted ingestion of fluids containing toxic amounts of fluoride.<sup>30</sup> Available scientific data indicate that 1 p.p.m. of fluoride added to a communal drinking water has proved to be completely innocuous.<sup>2,8</sup> Hodge<sup>12</sup> evaluated the status of existing knowledge concerning the metabolism of fluorides in the body. He stated: "When all the evidence is put together, it may be concluded that in water fluoridation adequate factors of safety exist against the known toxic effects of fluoride. The evidence does not justify the postponement of water fluoridation."

No specific etiological factor has yet been established for varicose veins<sup>31</sup> and there have been no indications of the influence of hormones as a factor producing varicosity.<sup>32</sup> Certainly, there has been no evidence presented to substantiate a conclusion that fluoridated drinking water causes varicose veins.

- c. **OBJECTION:** Fluorides cause hypertension.

**APPRAISAL:** Hypertension is not a disease. It is only a physical sign which occurs as a common constituent of the syndrome of several diseases. However, the conditions known to contribute to the development of hypertension are not associated with fluorides.<sup>29</sup>

Large doses of sodium fluorides, 5.0 mg. or more, actually produce the opposite

situation, called hypotension.<sup>33</sup> This property of fluorides has led to their use in the treatment of several persons suffering from hypertension, without evidence of toxicity.<sup>34</sup> Concentrations of about 1 p.p.m. of fluoride, as used in communal supplies of water do not produce or affect hypertension.<sup>35,36,37</sup>

- d. **OBJECTION:** Fluorides cause hypotension.

**APPRAISAL:** Studies have been conducted to determine the effects of sodium fluoride on blood-pressures. In one study, intragastric administration of 5.0 mg. of sodium fluoride to dogs, was observed to produce a lowering of the blood pressure.<sup>33</sup> In human beings there is the same tendency for large doses to cause a fall in blood pressure. Nevertheless, no such effects were obtained in another study in which only 1.0 mg. was administered. Hence, it may be concluded that the use of drinking water which contains 1 p.p.m. of fluoride would not produce a hypotensive response.<sup>35</sup>

Toxic concentrations of fluorides in the blood, produced by the ingestion of properly fluoridated water, is prevented by the body's highly efficient protective mechanisms. They include intestinal absorption, segregation in bone and elimination of the fluorides by excretion.<sup>12,35,36,37,13</sup>

- e. **OBJECTION:** Fluorides cause or aggravate heart disease.

**APPRAISAL:** A study by the United States Health Service<sup>38</sup> was made to compare rates of mortality associated with specific causes. All cities with 10,000 population or over in 1950 whose drinking water contained 0.7 p.p.m. or more of fluoride naturally present were included in the study. Each city with fluoride was paired with the average of the three closest cities which had less than 0.2 p.p.m. fluoride and populations of 10,000 and over. Deaths from diseases of the heart, cancer, and nephritis, adjusted for age, sex and race, in 28 fluoride and in 60 non-fluoride cities, failed to show significant differences.

Studies of other cities in which fluorides were added to the drinking waters led to similar conclusions.<sup>2,7,19,39</sup>

A comprehensive study by Hagan, Paster-nack and Scholz<sup>4</sup> was discussed previously in the appraisal of the objection based on cancer. One conclusion reached by the investigators was that there were no differences in the rates of mortality from diseases of the heart between the cities with and without fluoride.

Maxcy, Sterglotz, and Shock<sup>40</sup> in a report to the Commission on Chronic Illness, evaluated the effects of fluoridation by stating, "Research into the toxicology of fluorine

compounds has revealed no definite evidence that the continued consumption of drinking water containing fluorides at the level of about one part per million is in any way harmful to the health of adults or those suffering from chronic disease of any kind.

- f. **OBJECTION:** Fluorides produce coronary thrombosis or heart failure.

**APPRAISAL:** A search of the literature reveals no evidence to support this assertion. It is true that coronary disease is increasing and it is reported that 17 per cent of all deaths arise from coronary causes.<sup>29</sup> It should be recognized that the trend toward aging of the population, along with improved diagnostic methods, may be producing this situation.<sup>41</sup> Scientific evidence from numerous surveys and studies has not revealed that water, fluoridated to proper concentrations for the areas concerned, provides any hazards to health.<sup>12,36,39</sup>

6. Diseases and other conditions of the blood and blood-forming organs.

- a. **OBJECTION:** Fluorides cause hemophilia.

**APPRAISAL:** This assertion, no doubt, is based on the concept that fluorine influences the coagulability of blood. A hypothesis that hemophilia is due to an abnormally high content of fluoride in the blood was stated by Stuks and Lang.<sup>43</sup> However, later investigators have been unable to prove that any increased concentration of fluoride exists in the blood of hemophiles.<sup>25</sup>

Scientific evidence<sup>34</sup> indicates that the continued intake of low concentrations of sodium fluoride, such as those ingested in drinking waters, leads to no detectable deleterious effects on the blood or on any other part of the body.

- b. **OBJECTION:** Fluorides in the drinking water cause anemia.

**APPRAISAL:** A 10-year study of the effects of fluoridation in Bartlett and Cameron, Texas, included thorough medical examinations completed for each participant. Laboratory analyses were completed, including a determination of hemoglobin, counts of red and white cells, a differential count of white cells, and the completion of serological tests. Additional investigations of the blood were accomplished at a special period of the study, including hematocrit, rates for sedimentation and levels of blood-calcium. No evidence of anemia was found. Except for dental fluorosis due to excessive (8 p.p.m.) fluoride in the water supply of Bartlett, no clinically significant physiological or functional effects resulted from

prolonged ingestion of waters which contained the excessive amount of fluoride.<sup>44</sup>

Further evidence of the safety of water containing optimal concentrations of fluoride is found in the results of the comprehensive studies at Kingston and Newburgh. The completed reports concern participants exposed for a period of 10 years to ingestion of drinking water containing 1.0 p.p.m. of fluoride. Complete examination provided no evidence of anemia and revealed no differences of medical significance between the two cities.<sup>7,32</sup>

- c. **OBJECTION:** Fluoride in the drinking water produces leukemia.

**APPRAISAL:** Leukemia is a deadly disease of the blood-forming organs characterized by the proliferation of leucocytes.<sup>45</sup> Black and his co-workers<sup>9</sup> reported a series of observations from studies which included the feeding of sodium fluoride to patients dying of incurable cancerous conditions. Children with leukemia received a total daily dose of 80 to 200 mg., whereas the adult dose was 320 mg. daily. Even in periods up to six months no evidence of toxicity was detected. Microscopic examination of organs after death also revealed no damage to the tissues. Several investigators<sup>9,46</sup> have reported personal ingestions of as much as 250 mg. at a single dose, although an estimated dose of 105 mg. has been reported to be fatal. These experiments demonstrate that very large quantities of fluorine have been taken daily over a considerable period of time, by both man and animals, without detectable ill effects.

It is logical to conclude that the ingestion of drinking water containing low concentrations of fluoride will not cause leukemia inasmuch as significantly larger amounts taken for long periods have not produced the disease.

- d. **OBJECTION:** Abnormalities of leucocytes are caused by drinking fluoridated water.

**APPRAISAL:** The ingestion of moderate doses of sodium fluoride, such as those in concentrations of about 1 p.p.m., leads to no observable harmful effects on the elements of the blood, or upon any other part of the body, according to authoritative reports.<sup>44,9,7</sup> For generations, over 4,000,000 people in the United States have been living all of their lives in areas where drinking waters contain fluorides in concentrations as high as, or higher than, those recommended for dental health.<sup>47,48</sup> In many studies conducted among the people in these areas by competent investigators, no one has been able to find any adverse physiological effect except that of

fluorosis in areas where the concentration of fluoride is too high.<sup>48,13</sup>

Analyses of all available studies conducted over extensive periods of time in fluoride and fluoride-free areas provide no support whatsoever for a belief that abnormalities of the leucocytes are caused by drinking fluoridated water.

- e. OBJECTION: Fluorides in drinking water retard formation of leucocytes.

APPRAISAL: Specific evidence is available which indicates, in areas where optimal concentrations of about 1.0 p.p.m. of fluorides are ingested, that the count of white cells is essentially the same as in areas which have no fluoride in the drinking water.<sup>7</sup> Laboratory studies of the white cells in participants of another major study indicate that there was a tendency for the count to be increased in the area which had excessive fluorides in its water. However, the same study concluded that, since white cells normally are subject to wide transient variations and, in view of clinical experiences in the area, the finding does not suggest an association with the intake of fluoride.<sup>10</sup> No evidence was found to indicate that fluoridation retards the formation of leucocytes.

- f. OBJECTION: Water which contains fluorides increases the clotting time of the blood.

APPRAISAL: It has been reported that the addition of 0.4 per cent of sodium fluoride will prevent coagulation of shed blood.<sup>43,49</sup> However, it has been demonstrated that feeding sodium fluoride does not diminish coagulability of blood.<sup>43,43A,27,49</sup> Evidence indicates that coagulation is due chiefly to the inhibition of the formation of fibrin-ferment and not to the precipitation of calcium.<sup>43</sup> Biochemical studies demonstrate that the fluoride is eliminated promptly from all tissues, except bones and teeth, and that it is excreted in the urine, perspiration and feces. Therefore, the mechanisms of excretion and accumulation in bone provide effective means of regulating the content of fluoride in the fluids of the body to a level below that affecting enzymes. It is inconceivable that enough fluoride to alter the action of enzymes could be produced in the blood and fluids of the body by the use of fluoridated water of the concentration of 1 p.p.m.<sup>50</sup>

7. Mental and neurological abnormalities or diseases.

- a. OBJECTION: Drinking fluoridated water causes such conditions as:

- |                                                       |                                      |
|-------------------------------------------------------|--------------------------------------|
| (1) Neuroses                                          | (8) Neuritis                         |
| (2) Psychoses                                         | (9) Neuralgia                        |
| (3) Lowered mentality                                 | (10) Nail-biting                     |
| (4) Paresthesia                                       | (11) Poliomyelitis                   |
| (5) Stammering                                        | (12) Multiple sclerosis              |
| (6) Failing Memory                                    | (13) Degeneration of nervous tissue. |
| (7) Interference with transmission of neural impulses |                                      |

APPRAISAL: An exhaustive review of 1393 scientific references in the literature on fluoridation fails to provide any evidence of support for these allegations and no studies have been reported in support of the allegations, that could be investigated. On the other hand, reports of many comprehensive short and long-range studies by careful scientists have furnished conclusive evidence of the value and safety of fluoridation of communal supplies of water.<sup>51,52,4,8,10</sup>

- b. OBJECTION: Drinking fluoridated water causes intracranial lesions.

APPRAISAL: Hagen and his co-workers<sup>4</sup> studied rates of death from all causes and from five specific causes which included heart disease, cancer, *intracranial lesions*, nephritis and cirrhosis of the liver. The study covered 64 cities in 16 states and compared rates in the cities whose drinking water contained 0.25 p.p.m. or less of fluoride with other cities whose water contained 0.70 or more fluoride. These data showed no statistically significant difference between the rates for fluoride cities for the category of "all causes" or for heart disease, cancer, nephritis, cirrhosis of the liver, or *intracranial lesions*. Further verification and support of these findings have been demonstrated by Knutson and others based on observations from studies made in Wisconsin, Illinois and Texas.<sup>53</sup> Furthermore, no significant differences could be found in deaths from these causes (cancer, heart disease, or intracranial lesions) either before or after 1945 when fluoridation was started in Grand Rapids, Michigan.<sup>53</sup>

8. Diseases and defects of the eyes.

OBJECTION: The drinking of fluoridated water will produce disorders of the eyes such as (1) partial or complete loss of vision, (2) cataracts, (3) glaucoma, (4) detached retina, (5) conjunctivitis and (6) color-blindness.

APPRAISAL: Schlesinger and others<sup>7</sup> made special ophthalmological examinations, repeated over several years, of a group of 25 children as a part of the study of fluorine at Newburgh and Kingston for 10 years. The objective was to learn whether pathologic findings would exceed the expected rates for prevalence. On testing

visual acuity with the Snellen chart, the visions of 17 of the 25 children were found to be 20/20 or better. The findings in the ophthalmological examinations fell well within limits expected of any normal group of children of the ages studied.

Leone and his co-workers<sup>48</sup> completed a comprehensive 10-year study of two towns in Texas, Bartlett with 8.0 p.p.m. of fluoride and Cameron with 0.4 p.p.m. of fluoride. The study included examinations of the eyes for cataracts and lenticular opacities. The conclusion reached was that the differences in the rates for incidence and prevalence were not significant. No clinically significant physiological or functional effects resulted from prolonged ingestion of water containing excessive amounts of fluoride (8.0 p.p.m.), except dental fluorosis.

9. Diseases of the endocrine glands and dysfunctions not otherwise classified.

a. OBJECTION: Fluorides cause goiters.

APPRAISAL: Von Fellenberg<sup>54</sup> investigated the content of iodine and fluorine of water in relation to endemic goiter. He found that low incidence of goiter always was associated with high content of iodine; however, he also learned that high incidence of goiter occurred in areas which had waters which were either high or low in fluoride. Murray<sup>55</sup> and her co-workers demonstrated that studies of fluorine could not be conducted in relationship to endemic goiter unless the area's water was low in iodine. May<sup>56</sup> found no correlation between the occurrence of endemic goiter and high concentrations of fluoride in the water. He concluded, also, that there was no basis for a belief that a low rate for goiter is associated with a low content of fluoride in the water or that a high rate relates to high levels of fluoride.

The meticulous studies in Newburgh and Kingston<sup>52</sup> and in Bartlett and Cameron<sup>48</sup> have demonstrated that drinking water ranging from 0.4 to 8.0 p.p.m. of fluoride produced no physiological effects associated with goiter.

b. OBJECTION: Fluorides will cause degeneration of the thyroid gland.

APPRAISAL: Hein, Smith and Brudevold<sup>57</sup> reported studies of rats, given doses of radioactive fluorine, which showed that small amounts of fluorides go to the thyroid glands. However, they found, although the thyroid takes up some fluoride, that there is no such ability to concentrate it as with iodine. The essential consideration was pointed out by Hodge<sup>12</sup> who stated that "Histological thyroid changes have been

produced, but *always* as a result of large doses of fluorides."

It is highly significant to note that the study<sup>48</sup> in Bartlett and Cameron, Texas, which concerned comprehensive medical appraisals of persons drinking water containing from 0.4 to 8.0 p.p.m. fluoride produced no evidence to indicate that fluorides cause degeneration or other abnormality of thyroid glands. Hilleboe's<sup>52</sup> report of the study in Newburgh and Kingston, where the level of fluoride ranged from zero in Kingston to 1.2 p.p.m. in Newburgh, concluded that no differences of medical significance could be found between the participants in the study from the two cities.

c. OBJECTION: Fluorides in drinking water produce diabetes.

APPRAISAL: Extensive studies concerning possible relationships between waterborne fluorides and diabetes have been reported. Data comparing vital statistics were compiled by the Department of Public Health of the State of Wisconsin.<sup>46,19</sup> These data show a complete lack of correlation in rates of death for diabetes between cities whose water varied as much as 0.5 and 2.5 p.p.m. of fluoride. Moreover, no evidence was found in a 10-year study at Sheboygan to indicate that fluorides had any adverse effects on people's health. Although not statistically significant, the rates for diabetes actually dropped from 32.5 to 24.4 per 100,000 in Sheboygan after fluoridation. These statistical analyses are in agreement with separate studies made by the Department of Public Health of Illinois.<sup>2,18</sup>

Hagan and his co-workers,<sup>4</sup> in their analysis of comparable data on mortality in 32 paired-cities, concluded that their data revealed no statistically significant difference between rates of death for all causes between cities with or without fluoridated water supplies. Leone and his associates<sup>48</sup> reported that they found no significant differences in findings between the city of Bartlett, Texas, with 8.0 p.p.m. of fluoride, and the city of Cameron with 0.4 p.p.m.

d. OBJECTION: Fluorides cause impaired functioning or disease of the thyroid gland, the adrenals and the sex glands.

APPRAISAL: Evans and Phillips<sup>58</sup> reported a study of 40 patients to determine the relationship between the content of fluorine in the thyroid glands of patients experiencing hyperthyroidism. Portions of thyroids, obtained following the thyroidectomies of each patient, were analyzed for fluorine and iodine. No correlation between the fluorine of the gland and the basic metabolic rate of the patient was found. The investigators also stated that "the data gave no definite evidence that

fluorine in any way played a part in human hyperthyroidism by its action on the thyroid gland."

Harris<sup>59</sup> conducted a study designed to test the inhibitory effect of acute and chronic exposure to sodium fluoride on the gradient of uptake and the metabolism of iodine<sup>131</sup> by thyroid glands of rats. He found that (1) neither acute nor chronic dosages of sodium fluoride inhibited uptake of the diiodine<sup>131</sup> by the thyroid gland and (2) the iodine<sup>131</sup> was carried through the thyroid gland and reached the plasma of the blood without regard to differences in the levels of sodium fluoride which were administered in the study.

McClure<sup>60</sup> has concluded that physiological impairments in animals, which had been suggested by experimental studies of animals, have never appeared under actual conditions of exposure to drinking fluoridated waters.

Leone and others,<sup>44</sup> in their ten-year study in Bartlett and Cameron, Texas, specifically included data on the thyroid gland when gathering information on the prevalence of abnormal findings. They concluded that there was no statistically significant difference in the rates of abnormal thyroids in the two cities.

There have been no separate studies reported in the scientific literature concerning abnormalities of the adrenals or sexual glands in association with fluorides. Schlesinger<sup>7</sup> in his medical findings of the report on Newburgh and Kingston used the onset of menstruation as an index of the rate of sexual maturation. He concluded that no significant difference could be detected in the two cities in the proportion of girls who had passed the menarche.

Numerous scientific studies of fluorides<sup>7,9,10,19,20,25,44,48,52</sup> have discussed medical findings with meticulous attention to detail and objectivity. It seems reasonable to conclude that no abnormal findings were discovered in relationship to adrenal, thyroid or sexual glands. Furthermore, no evidence has been submitted to substantiate a belief that fluoridated water is harmful to these tissues.

- e. OBJECTION: Drinking fluoridated water will cause sterility.

APPRAISAL: Diminished fertility in rats has been reported by several investigators.<sup>60,61,62</sup> In each of these studies large quantities of fluorides were fed to the rats with their regular diets. However, Heyroth,<sup>20</sup> in evaluating these studies, concluded that the lesser fertility which occurred was secondary to poor growth or to weakness caused by lack of food. Phillips and his

co-workers<sup>63</sup> reported that dietary levels near the threshold for the inhibition of growth did not affect the estrus-cycle, although estrus ceased almost completely when the daily intake of fluoride reached 25 mg. per kg. of body-weight.

No evidence has been reported in the scientific literature to indicate that sterility is produced by drinking waters naturally fluoridated even at levels far exceeding 1.0 p.p.m. To establish that a condition has been caused or aggravated by consumption of fluoridated water, certain rules determine scientific acceptability. These rules require that it be established that the condition could have arisen only because of drinking fluoridated water and that relief was obtained by changing the source of water.<sup>64</sup> No evidence of this type is available concerning sterility. One must note, however, that evidence continues to be developed to support the comprehensive conclusion stated by Kehoe<sup>65</sup> that "The question of the public safety of fluoridation is non-existent from the viewpoint of medical science."

10. Diseases and other conditions of the skin, nails and hair.

- a. OBJECTION: Fluorides aggravate acne.

APPRAISAL: Epstein,<sup>66</sup> reported a study of 40 patients experiencing acne. The rate of improvement was no different in patients who took prescribed fluoride tablets and those who did not.

- b. OBJECTION: Fluorides will produce dermatitis.

APPRAISAL: The use of fluorides in high concentrations, for topical applications by professional personnel, may have raised this question. Abelson<sup>67</sup> reported one instance of dermatitis affecting the first two fingers and thumb of a dentist using fluorides for topical treatment for six months. A patch test of sodium fluoride gave a "late but plus-4 positive reaction." Cox and Hodge,<sup>8</sup> although they referred to Abelson's reported case, concluded that there is no danger of toxic sequelae. Only an estimated 10 mg. of fluorine is used so that Cox and Hodge do not consider the use of precautionary measures necessary.

In the study of McClure and his co-workers,<sup>15</sup> previously cited, five healthy young men were fed a diet supplemented by fluorine in various forms at different doses up to 6.0 mg. per day over periods of 21 to 26 weeks. Chemical analyses of all food, fluid and of all excreta (urine, sweat and feces) were made, at intervals, for the content of fluorine. The study revealed that

inflammation of the skin, which would indicate irritation, did not develop although the amounts of fluorine being excreted in the sweat were unusually high.

On the basis of these findings and additional reports concerning medical findings in studies of fluoridation, it is reasonable to conclude that dermatitis is not produced as a result of the fluoridation of public supplies of water.

c. **OBJECTION:** Drinking fluoridated waters causes damage to the skin, hair and nails which are manifested by conditions such as:

- (1) heat-spots
- (2) heat-lumps
- (3) boils
- (4) weals
- (5) athlete's foot
- (6) shriveled skin between the toes
- (7) eczema
- (8) brown discoloration of the skin
- (9) cracking of the skin at the corners of the mouth
- (10) alopecia
- (11) hives
- (12) lupus vulgaris
- (13) mottled nails
- (14) brittle nails

**APPRAISAL:** The effects of fluoridated water on the parathyroid glands have been declared<sup>68</sup> to cause abnormalities of the tissues regulated by these glands. These tissues include the skin and its appendages, the teeth, nails and hair. The conclusion that water fluoridated at a level of 1 p.p.m. is toxic is unsupported by evidence. Those making the assertion have not presented scientific proof to demonstrate that the assertions are facts rather than mere suppositions.

Horning<sup>69</sup> reported that a physician had distributed questionnaires in Highland Park and Saginaw, Michigan on poisonings caused by drinking fluoridated waters. The questions were "leading" in nature and certain symptoms were mentioned as part of these questions. Horning, after returning to his native Germany from the United States, translated this questionnaire and substituted the term "chlorination" for "fluoridation." Respondents in the city of Marburg, Germany, where the water is chlorinated, but contains only a trace (0.2 p.p.m.) of fluoride, answered the questionnaire. According to Horning, 25 of the 50 replies would have been recorded by the anti-fluoridationists as demonstrated instances of poisoning. It has been established that chlorinated water cannot produce poisoning. Therefore, Horning states that the positive answers received by the questioner were used for proof of poisoning that never existed.

In evaluating alleged abnormalities caused by diseased parathyroid glands, it appears significant that no evidence has been detected, even by the most comprehensive long-term medical studies,<sup>10,18,19,20,25,38,49,50</sup> that the drinking of fluoridated waters at recommended levels of approximately 1.0 p.p.m. will cause harmful effects to health.

11. **Diseases and abnormalities of the bones and joints.**

a. **OBJECTION:** Consumption of fluoridated water causes rickets.

**APPRAISAL:** The cause of rickets has been described by Dorland<sup>70</sup> as produced by a deficiency of vitamin D in which the normal process of ossification is disturbed. The disease is marked by bending and distortion of the bones under muscular action, by the formation of nodular enlargements on the ends and sides of the bones, and by delayed closure of the fontanelles. According to the final report of Schlesinger and his co-workers<sup>7</sup> in the study of the pediatric findings of the research in Newburgh and Kingston, no significant bony changes were detected by physical and radiographic examinations of people who had been drinking water fluoridated, at approximately 1.0 p.p.m. at the source, for a period of 10 years.

b. **OBJECTION:** Fluorides produce osteomalacia.

**APPRAISAL:** No evidence has been presented in the scientific literature to support a statement that fluorides in drinking water cause osteomalacia. Osteomalacia is essentially a result of a deficiency of vitamin D in adults which occurs during pregnancy in instances of malnutrition or during the menopause. A radiographic survey, conducted by Leone and others<sup>71</sup> at Bartlett, Texas, where the water contains 8.0 p.p.m. of fluoride, revealed no significant differences in the densities of bone in the persons examined. These findings were in consonance with the conclusions reached by Schlesinger and his co-workers<sup>7</sup> in the study of Kingston and Newburgh.

c. **OBJECTION:** Fluorides cause arthritis.

**APPRAISAL:** Dr. Charles L. Steinberg and others<sup>72</sup> recently have completed a study in which they determined the content of fluoride in bone, ligament and muscle of arthritic and normal individuals. Ages ranged from 40 to 86 years. Findings revealed that the amount of fluoride in the joints was normal in arthritic patients. The report concluded that "These studies indicate that there is no relationship between various arthritic

conditions and the musculoskeletal diseases. This study should dispel the fear that fluoridation of water, as recommended by health authorities, is a causation factor in arthritic conditions."

Another report by the same investigators<sup>78</sup> concerned a study of fluoridation as it relates to musculoskeletal diseases, including osteoarthritis, rheumatoid arthritis and rheumatoid spondylitis. The investigators were able to conclude that there was no relationship between the various arthritic conditions and the musculoskeletal diseases produced by ingestion of toxic quantities of fluorides.

Leone<sup>44</sup> and others, after their study of Bartlett and Cameron, Texas, concluded that there were no statistically significant differences in the clinical findings of arthritic conditions in the two towns.

- d. OBJECTION: Fluorides make the bones brittle.

APPRAISAL: It is a well-demonstrated physiological observation that fluorides are stored in bones. However, there is no scientific evidence to support a conclusion that fluorides, in concentrations of about 1.0 p.p.m., as used in communal drinking water, will produce brittleness of the bones.

McClure,<sup>73</sup> has reported that use of drinking water containing "upwards of 4.0 to 4.5 p.p.m. fluorine" had no effect on calcification of the carpal bones of children aged six to 13 years. Heyroth<sup>20</sup> concluded that "epidemiological data and clinical and radiologic examination of exposed industrial workers indicate that only when the fluoride content of a water supply exceeds 5.0 or 6.0 p.p.m. will its prolonged usage give rise to detectable osseous changes, and then only in the most susceptible persons."

McClure<sup>74,75</sup> made a direct study of the height, weight and experience of fractured bones of 1,458 high-school boys and 2,539 young adult males taking the physical examination at the induction centers for the United States Armed Forces. The participants were grouped in accordance with their residence in areas where the water contained 0, 0.1, 0.5, 1.2 and 1.8 p.p.m. of fluoride. Analyses of the data obtained revealed no statistically significant differences in their heights, weights or in the numbers of fractures of bones suffered by them.

- e. OBJECTION: Fluorides cause osteosclerosis.

APPRAISAL: It has been demonstrated that skeletal changes may be produced as toxic effects of fluoride. However, these changes occur only after long-continued exposure to extremely large amounts of fluoride, ranging from 20 to 80 mg. or more per day.

Radiographic evidence of increased density of bone was found in 21 of 178 residents of the Pampas, whose drinking water contained about 16 p.p.m. of fluoride.<sup>76</sup> Hodge and others<sup>77</sup> reported that none of approximately 140 residents of communities in which the drinking water contained 2.0 or 3.0 p.p.m. of fluoride or less had any detectable skeletal changes.

Steinberg<sup>78</sup> and others, have shown that the increased osteosclerosis found in rheumatoid spondylitis is not associated with increased deposition of fluoride.

This finding is supported by the conclusions of Schlesinger and others in their analyses of the pediatric data from the 10-year study of Newburgh and Kingston. Osteosclerosis is known to be an early manifestation of chronic intoxication by fluoride, and the lumbar portion of the spine is one of the earliest sites to show changes. Therefore, special attention was paid to the radiographs of the lumbar region of the spine. There were no detectable differences in the densities of the bones of the children from the two cities. There also were no differences in densities detectable in the wrists and knees of the children.

Hodge and Smith,<sup>2</sup> after evaluating the evidence available, concluded that "Between the amount of fluoride that will produce osteosclerosis in humans and the amount obtained by drinking fluoridated water (1 p.p.m.) there is a safety factor of 8- to 20-fold."

- f. OBJECTION: Fluorides cause osteoporosis.

APPRAISAL: A number of reports have been published which associate osteoporosis with fluorine or fluoride(s).<sup>76,79,80,81</sup> All of these reports indicate that the condition was found in conjunction with mottling of teeth. Concentrations of fluorides in the water supplies were reported to be 12 p.p.m.

The study of Newburgh and Kingston<sup>52</sup> has demonstrated conclusively that water containing the recommended concentration for optimal dental health, approximately 1.0 p.p.m., did not produce significant changes in bones during a period of 10 years.

Osteoporosis was one of the specific changes in bones upon which data were collected during the 10-year study of Bartlett and Cameron, Texas. Leone<sup>48</sup> and his co-workers reported that they found no significant differences in the density of the bones of the people of the two cities.

Hodge and Smith<sup>2</sup> have stated that the American public has a tendency to develop a gradual demineralization of the bones with increasing age, the process known as osteoporosis. In most people this demineralization is not a disadvantage, but, in some, the bone may become weak enough to fracture

easily. It is possible, therefore, that a positive benefit to the skeleton could be induced by an optimal fluoridation of water.

g. **OBJECTION:** Fluoridation causes exostoses.

**APPRAISAL:** It is true that the National Research Council,<sup>82</sup> through its Food and Nutrition Board, has reported that skeletal changes occur after long-continued exposure to large amounts, such as 20 to 80 mg. or more per day, of ingested fluoride. Exostoses also were mentioned as one of the possible chronic toxic effects. However, the same report concluded, after full consideration of all of the available information, that (1) children drinking fluoridated water will grow normally and (2) no detectable alterations will occur in bony structure at the recommended level of 1.0 p.p.m. These conclusions have been corroborated by other highly scientific long-term medical studies, including those reported by Hilleboe,<sup>52</sup> Leone<sup>44,46,10</sup> and others.<sup>83</sup> All of the scientific evidence clearly demonstrates a wide margin of safety in the use of levels of fluorides recommended for the control of caries.

h. **OBJECTION:** Fluorides produce ankylosis.

**APPRAISAL:** No instances of ankylosis have been reported in the various controlled studies concerning drinking waters which contain from 1.0 to 8.0 p.p.m. of fluorides.<sup>52,48,10,84</sup> It may be that fluoridation has been associated with rheumatoid (ankylosing) spondylitis, since these diseases have a clinical similarity. Steinberg and his co-workers<sup>78</sup> have shown, however, that the changes produced in bone by rheumatoid spondylitis is not associated with the skeletal deposition of fluorides.

i. **OBJECTION:** Drinking fluoridated water causes such conditions as swelling of joints, poor posture and flat feet.

**APPRAISAL:** No specific studies have been reported that test these assertions. Results of studies of the musculoskeletal tissues, which would be disturbed in the conditions mentioned, have been reported by Steinberg, Gardner, Smith and Hodge.<sup>85</sup> Their research shows that the musculoskeletal tissues are not harmed by consumption of water containing optimum amounts of fluoride. These findings are supported by the conclusions of other researchers.<sup>81,86,10,48,52</sup>

j. **OBJECTION:** Fluorides cause compression of the spine.

**APPRAISAL:** Most of the literature reporting instances of spinal compression caused by drinking water which contained large and toxic amounts of fluorides has come either

from China<sup>88</sup> or from India.<sup>87,88,89</sup> Venkataraman<sup>90</sup> of India stated that the high prevalence of rickets and osteomalacia produced by malnutrition in these two countries interferes with any diagnosis of disease of bone ascribed to fluorosis. Kilborn<sup>91</sup> has reported similar conclusions.

There are no reports of data or evidence of any kind in the literature to indicate that the use of drinking water containing the recommended level of fluorides at a concentration of 1.0 p.p.m. causes harmful effects in bone. On the contrary, evidence from each completed long-term medical study serves to demonstrate further confirmation of the safety of fluoridation of public supplies of water.

12. Diseases and abnormalities of the teeth and their supporting structures.

a. **OBJECTION:** Fluorides cause mottling and unsightly staining of teeth.

**APPRAISAL:** Mottled enamel has been described by Dean<sup>97</sup> as the dental manifestation of an excessive intake of fluorides consumed during the period of calcification of the teeth. The most sensitive indication of fluorosis is mottled enamel.<sup>93</sup> Dean,<sup>94</sup> who based his conclusions upon examinations of 5824 children in 10 states, showed a direct correlation between severity of mottling and increasing content of fluoride, up to 5.0 p.p.m. in supplies of water. At approximately 1.0 p.p.m., less than 10 per cent of the children showed the least detectable evidence of disturbances in formation of the enamel; they were very mild disturbances not accompanied by staining, and were visible only to the trained eyes of an experienced dentist. In fact, many dentists think that the increased whiteness associated with about 1 p.p.m. of fluorine in drinking water actually enhances the beauty of the teeth.<sup>95,96</sup> At about 2.0 p.p.m., an increasing proportion of children had mottled enamel that was apparent and objectionable esthetically. Maier<sup>97</sup> has reported mild dental fluorosis as developing when concentrations of fluoride are above 1.5 p.p.m. Dean<sup>98</sup> stated that "while the safe level of fluoride concentration to afford a maximum caries preventive effect without mottled enamel is approximately 1.0 p.p.m., it varies somewhat with climatic and other factors and must be ascertained for each general area. Galagan<sup>99,100</sup> stated that fluoride concentrations should be adjusted to climatic conditions. This adjustment for zones similar to the Great Lakes would require a concentration of fluoride at a level of 1.2 p.p.m. Galagan and Lamson<sup>99,100</sup> have indicated in hot dry climates, with a mean annual temperature

of 70° F., that as little as 0.6 to 0.8 p.p.m. of fluoride in water is considered equal in effectiveness to 1.2 p.p.m. in areas comparable to those surrounded by the Great Lakes.

It also is true that the margin between the optimal quantity of fluoride in drinking water which is required for maximal benefit and the amount which produces undesirable physiological effects is sufficiently wide to cause no concern.<sup>83</sup> For practical purposes of public health, it is merely a matter of using controlled dosages of fluorides adjusted to the mean annual temperatures in order to produce optimal concentrations for the zones where the water is consumed. The amounts, therefore, can be adjusted to a point where staining of teeth does not occur while, at the same time, fluoridation can serve to develop teeth which are highly resistant to dental caries.<sup>13</sup> There is no cosmetic hazard from this physiologic level of fluoridation, natural or controlled.<sup>88</sup>

- b. OBJECTION: Drinking fluoridated water produces hypocalcification of teeth and deterioration of the dentin.

APPRAISAL: Apparently these objections imply the ingestion of fluorides in amounts recommended for the reduction of dental caries causes failure of the teeth to calcify normally, or a change in calcification of dentin, or both conditions.

It is possible for many conditions or factors to produce defects in calcification during the development of teeth.<sup>101</sup> Among potential causes<sup>101,102,103,104,105</sup> are deficiencies of vitamins, hypoparathyroidism, traumatic injuries, fluorosis, certain infectious diseases (notably the severe exanthematous diseases and syphilis), and heredity.

The relationship between these various conditions and hypoplasia is not distinct. For example, Sarnat and Schour,<sup>105</sup> in their report of a study of dental hypoplasia in 60 patients, indicated that in many instances the etiology was uncertain. They concluded that the exanthematous diseases do not cause hypoplasias as frequently as has generally been concluded.

Hypoplasia can be and often is produced by the ingestion of excessive fluorides in early life.<sup>106,101,104</sup> In fact, dental fluorosis is endemic in areas where concentrations of 2.0 p.p.m. or more occur naturally in the drinking waters.<sup>93,79</sup> Increases in concentrations above about 1.5 p.p.m. cause increasingly severe mottling of the teeth.<sup>107</sup> Nearly all children drinking water containing 6.0 p.p.m. of fluoride during the period of calcification of the enamel will exhibit

moderate to severe degrees of mottling.<sup>97</sup> On the contrary, fluoride at levels of about 1.0 p.p.m. in the water, is sufficient to decrease the incidence of dental caries by about 60 per cent or more. The accompanying degree of fluorosis is negligible.<sup>97</sup>

Fluorine is a common constituent of teeth<sup>75</sup> and no evidence has been presented to indicate that increasing the content of fluoride will alter the content of calcium. Armstrong and Brekhus<sup>108,109</sup> found no significant differences in the amounts of calcium in teeth that were resistant to caries, and which contained larger than the usual amounts of fluoride, when contrasted with teeth that were susceptible to caries and which contained smaller amounts of fluoride. McClure<sup>75</sup> has reported that fluorine "When present in bones and teeth in trace quantities is compatible with normal physiological processes."

The phrase "deterioration of the dentin," although vague, seems to indicate that fluorides could bring about the withdrawal of calcium from the teeth. This belief is without foundation. Kronfeld,<sup>104</sup> after years of study, stated that "...the teeth are not subject to calcium withdrawal."

- c. OBJECTION: Pulpal stones may be caused by fluorides in drinking water.

APPRAISAL: No scientific evidence could be found in the literature to support a belief that the various types of calcified bodies found in dental pulps are caused by fluorides in drinking water. The etiology of these formations is vague. However, they have been considered to be the result of secondary degenerative changes, caused by chronic irritations of the pulp arising from deep restorations or dental caries, but frequently can be found in newly-erupted teeth. Hill,<sup>101</sup> in a study of the teeth of individuals 10 to 70 years of age, found that pulpal calcifications were very common. He reported calcifications in from 66 to 90 per cent of the teeth examined. However, it is pertinent to note that pulpal stones seem to be seldom, if ever, of clinical significance, according to Hill<sup>101</sup> and Kronfeld.<sup>104</sup>

Pulpal stones were studied by Zimmerman<sup>110</sup> and others as a part of the 10-year study in Cameron and Bartlett, Texas, previously described. Bartlett, with a water supply containing 8.0 p.p.m. fluoride, had a slightly lower prevalence (18.6%) of pulpal stones than did Cameron (23.8%), which had only 0.4 p.p.m. of fluoride in its drinking water. Actually there was no statistically significant difference in their rates of incidence. It is reasonable, therefore, to conclude that the presence of pulpal stones is unrelated to fluorides in drinking water.

- d. **OBJECTION:** Fluorides in the water will increase the incidence of dental caries.

**APPRAISAL:** Numerous scientific long-term studies have been completed which prove conclusively that this objection is not only unfounded but that fluorides are being used to decrease the incidence of the disease.

Hill,<sup>110</sup> in a review of the research on fluoridation, points out that three major studies of over 10 years each have been completed. All three areas reported statistically significant reductions in their rates for dental caries. Specific reports are available for Brantford, Ontario,<sup>84</sup> Grand Rapids, Michigan,<sup>112,113</sup> and Newburgh, New York.<sup>114</sup> The studies revealed no ill-effects of either a medical or dental nature. Many reports of studies reflect highly significant reductions in rates for carious teeth following fluoridation of communal water supplies. Other cities from which reports also are available include Evanston, Illinois,<sup>115</sup> Milan, Tennessee,<sup>116</sup> Madison, Wisconsin,<sup>117</sup> Maysville, Kentucky<sup>118</sup> and Marshall, Texas.<sup>119</sup>

Russell and Elvove<sup>120</sup> and Arnold<sup>121</sup> have indicated that fluoridated water supplies probably benefit people in adult life by reduction of dental caries. However, evidence concerning reductions of cavities in adults is still fragmentary and inconclusive.

The evidence that fluoride in drinking water reduces the incidence of caries in children is conclusive and based on exhaustive long-term studies by scientific and reputable investigators.

- e. **OBJECTION:** Fluorides in the drinking water will cause the teeth to die.

**APPRAISAL:** No evidence has been advanced to support the assertion that fluorides, even in excessive amounts, produce loss of vitality in teeth. Zimmerman and his co-workers,<sup>110</sup> from their studies in Bartlett and Cameron, Texas, concluded that the rates for prevalence of periapical rarefactions were the same in both cities. The report of this study indicates that, even in areas where fluoride is present in excessive amounts, loss of vitality of teeth is not a problem.

Maurice and Schour<sup>122</sup> studied histologic responses of the pulps of rats' molars to fillings which contained various concentrations of sodium fluoride in a bland-base filling material. They found no significant harm to the pulp within the 32-day period of their study.

More than 30 million persons in 1426 communities in the United States and about

500,000 persons in 23 Canadian communities were drinking fluoridated water in December 1956.<sup>124</sup> There has been no evidence presented to indicate that fluoridated water is causing any problem whatsoever by devitalization of teeth.

- f. **OBJECTION:** The consumption of fluoridated water causes or aggravates periodontal disease.

**APPRAISAL:** Russell and Elvove<sup>120</sup> reported in 1951 that natives of Boulder, Colorado, had lost slightly, but not significantly, more teeth because of periodontal disease than had natives of Colorado Springs where the water contained fluoride which varied seasonably from 1.8 p.p.m. to 3.0 p.p.m. In a later study, Russell<sup>125</sup> compared the prevalence of periodontal disease in communities with and without fluoridated drinking water. These communities were located in three different areas of the United States. As a part of his conclusions, Russell stated that "the findings are wholly incompatible with any hypothesis that periodontal tissues of children or adults are harmed by use of fluoride-bearing domestic water."

Russell<sup>126</sup> also compared the periodontal findings of the study in Boulder and Colorado Springs with his more recent study of communities drinking fluoridated or nonfluoridated water. He concluded that "the amount and severity of gum disease in the Colorado Springs group (using water with about 2.5 p.p.m.) was about the same as that since seen in the series of fluoride and nonfluoride communities. It was almost identical, for example, with the findings for Baltimore adults, then using a fluoride-free water."

- g. **OBJECTION:** Fluoride in the drinking water has caused malpositioning and loss of third molars.

**APPRAISAL:** The data cited in the original report of Russell and Elvove<sup>120</sup> have been used as evidence that use of a fluoridated water causes "stunted jaws and crooked teeth."<sup>126</sup> The statement was made in the earlier report of Russell and Elvove<sup>120</sup> that "At Boulder 94 per cent of third molar loss was reported as due to dental caries and about three per cent as due to malposition of the teeth. At Colorado Springs about 36 per cent of third molar loss was reportedly due to dental caries and about 62 per cent to malposition of the teeth. Russell<sup>126</sup> stated that "this objection rests on a basic misunderstanding of the dynamics of mouth development and tooth function."

Modern man's jaws frequently are too small, in fluoride and nonfluoride areas

alike, to accommodate all of the permanent teeth. Since the third molars are the last teeth to erupt, there often is too little room in the jaws for them to erupt properly, *provided all of the other teeth are still present*. There had been little decay and loss of permanent teeth ahead of the third molars in Colorado Springs.<sup>126</sup>

Loss of first permanent molars in Boulder (fluoride-free) because of decay, had been high. Generally, the third molars of people in Boulder had ample space for eruption. Therefore, for third molars, *which had been extracted*, more persons in Colorado Springs than in Boulder reported malposition as the cause for loss of teeth. This malposition was not caused by "stunting of jaws" but by *preservation* from decay — rather than *loss* from decay — of the much more valuable molars. It is of interest to note, when other molars still were present, that Russell found third molars out of position just as often in Boulder as in Colorado Springs. Russell has pointed out these findings in a recent article which discusses the objection raised, insofar as it relates to his research.<sup>126</sup>

- h. OBJECTION: Fluorides produce malocclusion of the teeth.

APPRAISAL: A search of the literature indicates that there are no reports of studies to support this assertion. There is, on the contrary, certain evidence which tends to substantiate the conclusion that malocclusion is not produced by fluorides in drinking water.

Pelton and Elsasser<sup>127</sup> conducted an epidemiological survey of malocclusion in which residents of a "fluoride-area" were compared with those of a "nonfluoride area." In this survey, an experimental measure of malocclusion called "the dento-facial index" was used. One of the conclusions reached by Pelton and Elsasser was that "while the dental caries-experience differed, the dento-facial index (DFI) was essentially the same in both communities." One can conclude from this study, therefore, that the relationships of the teeth were not disturbed.

Even when excessive fluorides have been ingested for 10 years, scientific studies<sup>110, 44, 52</sup> have not revealed any effects which could be construed to produce malocclusion. Zimmerman<sup>110</sup> did not note malocclusion among any of his findings in the study of Bartlett and Cameron.

There are numerous positive findings by scientific investigators that dental caries is reduced by drinking fluoridated waters.<sup>84, 112, 113, 114, 115, 120, 121, 128</sup> Russell<sup>126</sup> has pointed out that loss of teeth through decay often results in drifting of the adjacent

teeth to fill gaps. Since such drifting is a recognized common cause of malocclusion, it should be noted that fluorides, when acting to reduce caries and loss of teeth, also act to prevent rather than cause malocclusion.

Lastly, it has been demonstrated that there are no changes in rates of eruption of teeth which result from drinking fluoridated water containing less than 2.0 p.p.m. of fluoride.<sup>129</sup>

- i. OBJECTION: The consumption of fluoridated drinking water will cause opalescent dentin.

APPRAISAL: Opalescent dentin or dentinogenesis imperfecta is a disorder characterized by a generalized hypoplasia of the dentin. The enamel and cementum are not disturbed. The attachment of the enamel to the dentin is weak so that chipping of the enamel occurs frequently. The dentin thus exposed varies from light to dark brown in color.<sup>101, 102, 104</sup> Hill<sup>109</sup> explains the cause of the opalescent dentin in his statement that "Although the condition is one of hypoplasia, it apparently is not influenced by dietary or toxic influences on the formative cells, but is solely the result of hereditary traits which produce imperfect tooth structure."

It seems plausible that an untrained observer might mistake this type of hypoplasia for that associated with moderate to severe fluorosis. This misconception could be the basis for the assertion. It is essential to note, however, that no such obvious dental fluorosis is caused by the small amounts of fluorides recommended for the partial control of dental caries.<sup>97, 107</sup>

13. Miscellaneous conditions.

- a. OBJECTION: Fluorides cause general protoplasmic poisoning.

APPRAISAL: Cox and Hodge,<sup>8</sup> in describing the mechanism of acute fluoride poisoning, stated that "Some of the basic and necessary metabolic processes in the cell are stopped by concentrations of fluorides such as are found in acute poisoning. These changes are comparable to those seen in high-grade anoxia and are the basis for describing fluorides as general protoplasmic poisons." The average fatal dose for man has been estimated by Cox and Hodge to be in the order of 50 mg. per kilogram of body weight.

However, the pertinent issue is whether fluorides in dosages recommended for use in drinking water cause harmful effects. Black<sup>130</sup> has pointed out that all compounds used for the fluoridation of water long have been known as poisons, when ingested in massive doses. Other useful materials also

are corrosive agents when used in massive doses. Black calls attention to the chlorine used in sterilization of water, and the soda-ash and quick-lime used in softening of water. Many medicaments routinely used to cure diseases are deadly poisons when taken in sufficient doses.

Heyroth<sup>20</sup> has reported that the results of experimentation with animals show that the prolonged intake of quantities of fluoride to produce dental fluorosis does not give rise to any of the non-dental manifestations of chronic intoxication by fluorides.

Kehoe<sup>63</sup> has summarized the status of fluorine's toxicity by stating that "The question of the public safety of fluoridation is non-existent from the viewpoint of medical science."

- b. **OBJECTION:** Fluorides are toxic to pregnant mothers and babies before and after birth. Fluorides cause abortions, stillbirths and prematurity of birth.

**APPRAISAL:** Studies in Wisconsin<sup>10</sup> have provided data which show that there is no important or consistent difference in the frequency of stillbirths, premature births, neonatal deaths, infant deaths or maternal deaths in several Wisconsin communities. The studies covered two successive five-year periods. Fluoride content in the water ranged from 0.03 p.p.m. to 2.5 p.p.m. The same pattern was observed in the city of Sheboygan, Wisconsin during the five-year period following the raising of the content of fluoride in its water.<sup>13,19</sup>

The study in Newburgh and Kingston included long-range pediatric studies by Schlesinger and others.<sup>7</sup> Comparison was made of the rates for stillbirth, maternal and infantile mortality in the two cities for a period starting five years before the initiation of fluoridation and during the 10 years of the study. Although the annual rates for mortality varied considerably, the long-range downward trends were similar in the two cities. There was no detectable change in the trend in Newburgh after fluoridation.

Studies of the Illinois Department of Health in 1952 revealed that the death rate in the period from birth to four years in 22 cities showed no significant difference between the fluoridated and nonfluoridated areas.<sup>19</sup>

- c. **OBJECTION:** Fluorides in the drinking water will cause tonsillitis.

**APPRAISAL:** As a part of the 10-year studies made of children in Newburgh and Kingston, New York, evidence has been reported<sup>7</sup> on the numbers of tonsillectomies performed in the two cities. Newburgh had a significantly higher proportion of

tonsillectomies when compared with similar age-groups in Kingston. Schlesinger and his associates<sup>13,2</sup> had reported this observation at the end of the first six years of the study of fluoridation. In the final report,<sup>7</sup> in consonance with their previous report, the investigators noted that the difference in rates of tonsillectomies had existed prior to the start of the 10-year study and that the situation reflected differences in medical practice between the two cities.

No evidence, hence, has been produced to indicate that there is a connection between the incidence of tonsillitis and drinking fluoridated waters.

- d. **OBJECTION:** Fluorides added to supplies of water will cause serious damage to the internal organs.

**APPRAISAL:** Long-range studies conducted by competent investigators have produced substantial evidence that fluoridation of drinking water to the proper concentration of approximately 1.0 p.p.m. is beneficial and produces no harmful effects on people.<sup>10,48,52</sup> Careful observations of individuals who have lived up to 70 years or more in areas where water has a high concentration of fluoride have not revealed injuries to the internal organs.<sup>13,48</sup> In the town of Stratford, Ontario, where water has been fluoridated to a level of 1.6 p.p.m. continuously for 38 years, physicians were asked individually whether or not they had observed any ill effects upon internal organs from the fluoride in the water. All reported that they had observed no ill effects to the internal organs.<sup>64</sup>

- e. **OBJECTION:** Fluorides produce serious loss of weight to a point of emaciation.

**APPRAISAL:** Schlesinger and his co-workers,<sup>7</sup> in the studies of Newburgh and Kingston, made careful measurements of the weights and heights of each child. No significant differences were found between comparable age-sex groups in the rate of increase during the 10-year period of the study. Leone,<sup>10</sup> reporting on the 10-year medical study in Bartlett and Cameron, Texas, stated that "When the data are reviewed critically, it is clear that the medical characteristics of the two groups, with the exception of dental fluorosis, do not differ more than would be expected of two comparable towns with or without an excess of fluoride in the water supply.<sup>11</sup> Loss of weight was not reported in either study.

Analyses of the vital statistics from health departments of Wisconsin<sup>19</sup> and Illinois<sup>19</sup> disclose no evidence over a 10-year period to indicate that fluoridation has

had any adverse effects upon the health of the people of those states.

- f. **OBJECTION:** Fluorides will cause people to be left-handed or may make them ambidextrous.

**APPRAISAL:** There is no known evidence which relates handedness to fluorides in drinking water. However, detailed long-range studies of the development of handedness in infants and children have been reported by Gesell.<sup>133</sup> These studies show that opposing developmental trends appear to govern right- or left-handedness. These opposing trends to produce either right- or left-handedness, or both, are all variables of the inherited processes of individual growth and development. There was no relationship to fluoridation noted in these studies.

- g. **OBJECTION:** Drinking water which has been fluoridated will lead to loss of hearing.

**APPRAISAL:** The effects of drinking fluoridated water were observed specifically in long-range studies. Schlesinger and his co-workers reported that the study of Newburgh and Kingston revealed no differences in the findings of otological examinations and audiometric testing of the children in the two cities. There were 500 children tested in Newburgh, where the water was fluoridated to a level of 1.2 p.p.m. of fluoride, and a total of 405 children tested in Kingston, where the water essentially was fluoride-free for the 10-year period of the study. Examinations revealed no differences of medical significance between the two groups. The otological findings fell well within the normal limits expected for the ages studied.

Leone and his associates,<sup>48,110</sup> in the studies of Bartlett and Cameron found, even with drinking water fluoridated at 8.0 p.p.m., that there were no statistically significant differences in the number of persons in the two cities who had experienced loss of acuity of hearing.

Cox and Hodge<sup>8</sup> have suggested that "there is some possibility that fluoridation of water supplies may have beneficial effects on hearing." The studies of Lewy<sup>134</sup> appear to support this suggestion since he found hearing defects in 4.9 per cent of 109,869 children from districts low in fluoride in Illinois and 2.8 per cent in 20,448 from districts with fluorine not over 1.4 p.p.m.

- h. **OBJECTION:** Fluorides in the drinking water will cause headaches.

**APPRAISAL:** The headache has long been recognized as a common symptom of various physical or mental disorders.

However, a review of the scientific literature reveals no evidence whatever to substantiate a belief that drinking fluoridated water in concentrations of 1 p.p.m. causes headaches. Headaches were not mentioned among medical findings reported in numerous long-term studies of cities using fluoridated drinking water.<sup>7,39,48,52,84,107,112,135</sup>

- i. **OBJECTION:** Fluorides will cause inflammation of the mucous membranes.

**APPRAISAL:** It is true that repeated exposure of industrial workers to the vapors of concentrated hydrofluoric acid may produce inflammation and ulceration of nasal and oral mucosa. However, it is pertinent to note the studies of Rabuteau<sup>136</sup> and Baldwin<sup>137</sup> of the effects of acutely toxic doses taken by mouth for experimental purposes. The oral doses taken by each of these men was approximately 110 mg. and, therefore, slightly exceeded the lethal dosage of 105 mg. as calculated by Gettler and Ellersbrook.<sup>138</sup> Although reports of these studies describe symptoms of nausea, retching and intense salivation, there is no mention that the mucosa has been inflamed in the process. However, according to Steinberg and his associates,<sup>85</sup> the ingestion of very large doses at one session, such as taking fluoride for suicide, results in collapse, shock and death within 24 hours. Examination of material at necropsy shows multiple hemorrhages in the entire gastro-intestinal tract. Obviously, inflammation has occurred in the mucosa.

Studies of water fluoridated to a level of 1.0 p.p.m. have disclosed no evidence that inflammations of the mucous membranes occur from its use. It seems reasonable to assume that thousands of oral examinations made in the course of the various studies of fluoride over periods in excess of 10 years would have revealed mucosal inflammations, had they been present in a significant percentage of the populations studied.

- j. **OBJECTION:** Fluorides in the drinking water will produce muscular disturbances.

**APPRAISAL:** Muscular twitchings are produced by the ingestion of massive doses of fluorides which are sufficient to cause severe poisoning.<sup>8</sup> Rabinowitch<sup>139</sup> described such an instance, in which the person committed suicide. The subject had spasms in the hands and feet and died of respiratory failure in about three hours. A sample of blood, taken a few minutes before death, showed 2.6 mg. of calcium per 100 ml. of serum. The normal calcium level is 9 to 11.5 mg. The low blood calcium may be the basis for the muscular twitchings observed in severely poisoned individuals.<sup>8</sup> The minimal dose known to have caused death

from sodium fluoride has been stated by Roholm<sup>25</sup> to be 4.0 gms. of sodium fluoride. However, more recent studies have been made of the dosages of fluorides that produce acute and subacute toxicity. Postulated toxic doses, based upon accelerated poisonings and suicide, are about 4.0 to 5.0 grams, if administered intravenously.

The toxic intravenous dose of 4.0 to 5.0 grams is 16,000 to 20,000 times the trace amount contained in an eight-ounce glass of water fluoridated at 1 p.p.m.<sup>140</sup> It is an accepted and pertinent observation that an oral dose of most toxic substances is twice the intravenous dose.<sup>140</sup> Only in those studies concerned with severely toxic doses of fluorides have there been findings of muscular reactions. It is apparent that there is a very large margin of safety in the use of water that contains a concentration of only one p.p.m. of fluoride.

- k. **OBJECTION:** Allergies and edema are produced by fluorides in the drinking water.

**APPRAISAL:** The assertion that allergies or edema are produced by fluoridated drinking water is not supported by scientific evidence.<sup>141</sup> The long-range studies of people in cities using from 1.0 up to about 8.0 p.p.m. of fluoride in their drinking water do not record allergies or edema among even minor findings.<sup>10,48,7,12,52,39,84</sup>

Available scientific evidence indicates that edema and the allergies are not more prevalent in endemic fluoride areas even when the water consumed contains as much as eight times the amount of fluoride which is recommended for the partial control of dental caries.<sup>48</sup>

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B. Other related claims and statements:

1. **OBJECTION:** Through just one twist of a valve, an enemy could flood the city with poisonous fluorides and kill off the whole population.

**APPRAISAL:** Saboteurs would find the use of fluorides a highly ineffective means of poisoning the population. It has been estimated by Cox and Ast<sup>1</sup> that more than four tons of sodium fluoride per million gallons of water would be required to produce a concentration of 1000 p.p.m. of sodium fluoride or about 450 p.p.m. of fluorine. Such a concentration of sodium fluoride is 0.25 grams in an eight oz. glass of water, and this concentration is sufficient to cause acute illness manifested by salivation and vomiting. Leone<sup>2</sup> indicates that the acutely toxic dose is about 4.0 to 5.0 grams, when given intravenously.

Cox and Hodge<sup>3</sup> have evaluated the possibilities of suddenly adding tremendous amounts, such as a day's supply of fluoride, to the water of a large city like Rochester, New York. They state, for the amount to be deadly, that a total of 400 tons of fluoride would have to be added to the daily distribution. Since the large machine which feeds the fluoride has only a 1000 lb. hopper, acute poisoning is impossible. The same circumstances apply to other cities, making it mechanically impossible to poison a populace deliberately, or accidentally. Additionally, the huge quantities of fluorides necessary to attain a lethal dosage would be unavailable in local waterplants. Furthermore, it is unlikely that a saboteur would attempt to rely on tons of sodium fluoride when one ounce of the toxin of botulinus in a reservoir would exert a much greater effect. It appears obvious that there need be no fear that fluorides will be used for the purpose of poisoning a population's supply of water, either accidentally or deliberately.<sup>2,4,5,6,7,8</sup>

2. **OBJECTION:** There may be variations in the reactions of different people to fluorides.

**APPRAISAL:** A thorough review of the numerous scientific long- and short-term studies<sup>10,11,12,13,14,15,16,17</sup> provide conclusive evidence that fluoridation of water supplies is safe and beneficial. Leone and his co-workers<sup>10</sup> conducted meticulous studies during a period of 10 years in Bartlett and Cameron, Texas. Participants in the study ranged from 15 to 68 years of age at the beginning of the investigations in 1943. In 1953 the average length of exposure to fluorides was 36.7 years. No significant differences in the findings in the two towns were observed, except for a higher rate of cardiovascular abnormalities in Cameron (fluoride-free)

and a marked predominance of dental fluorosis in Bartlett (8.0 p.p.m. fluoride).

The Commission on Chronic Illness concluded its deliberations on the effects of fluorides on persons who had experienced chronic illness with a recommendation that urged American communities to adopt fluoridation as a positive step in preventing the chronic disease of dental caries.<sup>11</sup>

Hagen and his associates<sup>12</sup> studied the effects of drinking, or of not drinking, fluoridated water for variations in rates of mortality. Figures on mortality from 64 cities were analyzed, after adjustments had been made for age, race and sex. The analyses of the data showed no statistically significant differences between the rates of death in the fluoride and non-fluoride cities from all causes or from diseases of the heart, cancer, intracranial lesions, nephritis, or cirrhosis of the liver.

The only variation that has been observed is in the degree of mottling that is produced when people vary their intake of water. Galagan<sup>18</sup> and Lamson<sup>18,19</sup> have shown that the mean annual temperature is the most practical measurement now available of climatic conditions. Dean<sup>20</sup> states that "although the safe level of fluoride concentration to afford a maximum caries preventive effect without mottled enamel is approximately 1.0 p.p.m. this level varies somewhat with climatic and other factors and must be ascertained for each general area." As an example of meeting this problem, Stadt<sup>21</sup> has cited the action taken in Charlotte, North Carolina. Seasonal variations, based upon the mean monthly temperatures of the air, were determined and levels of fluoride then were prescribed. These levels ranged from 0.6 p.p.m. in July to a high of 1.1 p.p.m. in January and February. The average annual level of fluoride was about 0.9 p.p.m. The plan has been in operation since March, 1950, without difficulty of any consequence.

Studies made over a period of seven years at the Southbury (Connecticut) Training School have failed to reveal any evidence of injury to middle-aged and elderly inmates or employees. Examinations have included skeletal radiographs, urinary studies and examinations of smears, and occasional studies of liver-function.<sup>22</sup>

3. **OBJECTION:** Sick people, particularly those with diseases of the kidney, have a low tolerance for fluoride.

**APPRAISAL:** After an exhaustive investigation of all aspects of fluoridation, the St. Louis Medical Society stated "No evidence of injury to the well-being of any person, sick or well, infant or aged, has been related to fluorine present in water in physiologic concentration."<sup>23</sup>

The 10-year comprehensive medical studies in Bartlett and Cameron, Texas, and in Newburgh and Kingston, New York, produced no findings which could be related to low tolerances for persons experiencing diseases of the kidney.<sup>2,16</sup> Statistical studies in Illinois<sup>13</sup> and Wisconsin<sup>14</sup> and the comprehensive investigations by Hagen and his co-workers<sup>12</sup> in 64 American cities also revealed no statistically significant findings to indicate that there were differences in the rates of mortality between cities whose residents drank fluoridated water and those whose residents did not. Nephritis was one of the diseases specifically evaluated.

Harmful effects upon the kidneys and other non-skeletal tissues have not been observed in experiments with animals until quantities or concentrations about 100 to 500 times those utilized in the fluoridation of water are administered.<sup>22</sup> For example, Roholm<sup>24</sup> noted effects upon the kidneys of dogs when they received 5.0 to 8.0 mg. per kg. of body weight per day. By way of contrast, Doty<sup>22</sup> points out that the average adult, to ingest this amount of fluoride, would have each day to drink 80 to 100 gallons of water which contained 1.0 p.p.m. of the fluoride ion. The American Water Works Association<sup>25</sup> states that over 4 million persons in the United States have used water for years, which contained 0.7 to 3.0 p.p.m. or more of fluoride. In Texas, alone, 60,000 persons drink water containing 3.0 to 5.0 p.p.m. of fluoride.<sup>28</sup> Special studies in these areas have revealed no evidence of injuries other than mottled enamel produced to the relatively high content of fluoride. The study of the Southbury (Connecticut) Training School<sup>22</sup> disclosed no evidence that middle-aged or elderly persons were being injured by the use of fluoridated water.

Black and his co-workers<sup>27</sup> made a series of observations, highly pertinent to the functioning of the kidneys of 70 adults and children who were dying of incurable cancerous conditions. Sodium fluoride was fed in capsules; adults received 320 mg. and children 80 to 200 mg. daily. The usual period of medication was three to four months. Even for periods up to six months no evidence of acute or chronic intoxication was detected. Microscopic examinations of organs after death from the cancer also failed to reveal damage to tissue. One patient is reported to have received 5600 mg. intravenously in doses of 400 mg. over a period of 9 days without apparent toxicity. Short-term studies such as these are used to demonstrate that surprisingly large quantities of fluorides have been taken daily, under careful scrutiny and often over several months, by man and animals, without detectable ill effects. However, it should be noted that programs for the fluoridation of water use a daily dose of only 1.0 mg. per individual, young or old, sick or well.<sup>22</sup> Research conducted at the National

Institute of Dental Research<sup>13</sup> on more than 50 persons, who had evidence of damaged kidneys and who drank water containing 1 p.p.m. of fluoride, showed that the excretion of fluorides by patients with damaged kidneys is similar to the pattern of excretion for healthy young men, as reported by McClure.<sup>28</sup>

4. OBJECTION: Fluorides block rather than aid calcification when magnesium also is present in the water.

APPRAISAL: This objection is based on an assertion that, in the presence of the magnesium ion, the fluoride ion blocks calcification, *in vitro*. The assertion has not been substantiated with evidence. On the contrary, McClure,<sup>29,30</sup> has reported that there is no evidence to show that magnesium interferes with calcification. He found, further, that magnesium does not influence the inhibitory effect of fluorides on caries. In his studies with rats, McClure found that 10 p.p.m. of fluorine in drinking water which contained 500 p.p.m. of magnesium, reduced dental caries to the same extent, as did 10 p.p.m. of fluorine alone. No alteration in the degree of calcification was found. Other studies<sup>31</sup> support McClure's findings. Investigations by others also have shown that calcification of human teeth is not prevented by the consumption of water which contains optimal amounts of fluorides.<sup>32,33</sup>

5. OBJECTION: Fluoridation should not be undertaken because the final knowledge of the effects of fluorides on human beings is unavailable.

APPRAISAL: It is probable that fluoridation has been debated more widely in recent years than almost any other health measure. Opponents to fluoridation have questioned its safety, benefits, expense, and even the motives of those favoring it. Proponents have sought factual answers based on research. Evaluation of the scientific facts, determined through short and long-range studies, with some covering periods of 10 or more years, has led to endorsements of the use of fluoridation by numerous national organizations for health.<sup>34</sup>

The values of fluoridation, including its safety, practicality and desirability and its medical and legal aspects, have been explored thoroughly.

Over 8500 sources of information are available. A digest has been published which summarizes this knowledge and the practical experience of scientists who have worked with fluoridation.<sup>34</sup>

Final knowledge is incomplete in virtually every phase of living. The following quotations, however, may indicate why fluoridation is so widely accepted by conservative and reputable organizations for health.

Dean,<sup>35</sup> on the topic of practicality and desirability, stated, "fluoridation is a proven, effective, cheap and safe method for the partial control of dental caries." Arnold,<sup>35</sup> in considering the dental aspects, stated "... the reports present conclusive evidence of the effectiveness of the procedure in reducing dental caries." Ast,<sup>35</sup> stated that "The results of the Newburgh-Kingston Study coupled with similar studies independently conducted in Grand Rapids, ... Evanston, ... Brantford ... and elsewhere put the matter of dental benefits beyond doubt." Leone,<sup>35</sup> on the medical aspects, stated, "We know without question or doubt, that one part per million fluoride in a water supply is absolutely safe, is beneficial, and is not productive of any undesirable effect in man."

As with all public health measures, studies of fluoridation will be continued. However, more than adequate knowledge is available to promote the use of fluoridation as a safe and effective procedure for the partial control of dental caries.<sup>35</sup>

6. OBJECTION: Fluorides are toxic substances found in rat poisons and insecticides.

APPRAISAL: This assertion is true. No one has questioned that very large doses of fluorides are toxic. However, it is essential to emphasize two distinctly different aspects of fluorides. One aspect concerns the serious toxic effects from massive doses or from gross exposure to industrial fluorides. Such overdoses may occur from suicidal attempts or from occupational hazards such as inhalation of dusts containing high amounts of fluorides. The other aspect of fluorides concerns evaluation of the effects of trace amounts of fluoride which occur naturally in water supplies or which are introduced mechanically.<sup>37</sup>

The implication that fluorides in large doses and in trace amounts have the same effects is completely incorrect. Many substances in common use by human beings are beneficial in proper amounts but may be harmful when used improperly. For example, chlorine, a deadly gas in its concentrated state, is a useful purifier of most supplies of water. Even sodium chloride is poisonous in large quantities, yet it is ordinary table salt.<sup>38</sup>

The safety of drinking water which has been fluoridated to optimal concentrations of about 1.0 p.p.m. has been demonstrated beyond scientific question.<sup>37</sup>

7. OBJECTION: Fluorides are poisonous to goldfish, shellfish, tropical fish, chinchillas, birds, cats, cattle, and other animals.

APPRAISAL: Drinking waters containing fluoride ion at a concentration ranging from 0.7 to

3.0 p.p.m., or more, have been used by four million people in the United States for many years.<sup>22</sup> According to the Public Health Service, there are now 1492 communities, comprising a population of over 31 million people who drink water which is controlled to optimal concentrations.<sup>38</sup> No evidence has been produced to show that use of these waters is harmful to fish, birds or animals.

The Curator of Fishes, University of Michigan Museum, has stated that water fluoridated to 1 p.p.m. has no effect on the growth of tropical or gold fish.<sup>39</sup> This opinion was corroborated by a demonstration in Indianapolis where an aquarium using fluoridated water, was filled with healthy goldfish and then exhibited in the lobby of the water company. The fish suffered no adverse effects.<sup>40</sup>

Sognaes and his associates,<sup>41</sup> in an official report to the National Research Council, stated that in several species of animals — mouse, rat, rabbit, guinea pig, chicken, dog, swine, sheep, cattle, goat and monkey — rations containing less than 100 p.p.m., consumed for periods of a year or less, produced no deleterious effects on growth. Rabbits could grow normally with dietary fluorides at 200 p.p.m. and swine at 300 p.p.m.

Maximum dosages which may be tolerated as a daily intake, in milligrams per kilogram of body weight, by animals of various species have been determined by Schmidt and Rand.<sup>42</sup> Dosages in mg. are within the following ranges: dairy cattle 1-3, swine 5-12, rats 10-20, guinea pigs 12-20, and chickens 35-70 mg.

The dosages stated concern large amounts of fluorides and are included to illustrate that there is a wide margin of safety for animals in their use of water which has been fluoridated to a level of about 1 p.p.m.

8. OBJECTION: Fluorine has an antagonism to oxygen and to any tissue that has anything to do with oxygen or respiration.

APPRAISAL: A number of studies have been carried out in laboratories to determine the effects of fluorides on consumption of oxygen and effect on respiration. Aubel and his co-workers<sup>47</sup> reported evidence that high concentrations of fluorides, in the presence of glucose, tend to inhibit respiration and consumption of oxygen.

Burnett<sup>48</sup> concluded that fluorides in concentrations ranging up to 200 p.p.m. have little effect on the consumption of oxygen by the microbial flora of human saliva, provided that no carbohydrate is added. Burnett showed, when carbohydrate up to two per cent is added, that fluorides in concentrations of 200 p.p.m. moderately depressed the consumption of oxygen.

However, Borei,<sup>49</sup> concluded from studies of the effects of fluorides on respiration, that "the complete inhibition of respiration cannot be obtained." Aside from these studies in the laboratory of the effects of highly toxic dosages of fluoride, there are the impressive studies of Roholm.<sup>24</sup> Roholm pioneered in research on fluorides by observations of miners who were exposed to the dust of cryolite laden with a concentration of 48 to 52 per cent of fluorides.

The results of the many long- and short-term studies, some lasting in excess of 10 years, do not provide any evidence whatsoever that water, fluoridated even up to 8.0 p.p.m., will cause any harmful effects to the respiration or damage of tissues associated with the metabolism of oxygen.<sup>10, 12, 13, 14, 15, 16, 17</sup>

9. **OBJECTION:** Fluorine acts as a catalyst in accelerating certain pathological processes.

**APPRAISAL:** The evidence produced by the long-term studies of the medical aspects of fluoridation does not support this assertion. The investigations in Grand Rapids and Muskegon, Michigan,<sup>17, 50</sup> Bartlett and Cameron, Texas,<sup>10</sup> Newburgh and Kingston, New York,<sup>16</sup> and Brantford, Sarnia and Stratford, Ontario,<sup>15</sup> each lasted for a period of 10 or more years. Their outcomes indicated that no harmful effects were produced by the use of physiologic dosages of fluoride. Hagen and his co-workers<sup>12</sup> analyzed data obtained from 32 pairs of cities. One city of each pair used fluoridated water, the other did not. All rates were adjusted for age, race and sex. The report revealed that no statistically significant differences existed between the rates of mortality in fluoride and non-fluoride cities for all causes or for heart disease, cancer, intracranial lesions, nephritis or cirrhosis of the liver.

Each major study of fluoridation serves to add more confirmation to the uniform conclusion of the others which was summarized by Leone<sup>37</sup> in his statement: "We know, without question or doubt, that one part per million fluoride in a water supply is absolutely safe, is beneficial, and is not productive of any undesirable systemic effect in man."

10. **OBJECTION:** Fluorides are more toxic in a warm climate.

**APPRAISAL:** The toxicity of the fluoride is not increased in a warm climate. However, the opportunity for overdosage is greater. Studies by Galagan and Lamson<sup>18, 19</sup> show that children born and raised in areas with a mean annual temperature of 70° F. consume approximately twice as much water as children in

areas with a mean annual temperature of 50° F. A second finding was that comparisons of indices of dental fluorosis indicates that, with comparable concentrations of fluorine, fluorosis occurs at about twice the intensity in the southwestern part as it does in the midwestern part of the United States.

These findings indicate that the concentration of fluoride should be adjusted for climatic conditions. Galagan<sup>18</sup> concluded that 1.2 p.p.m. of fluoride may be considered optimal in zones comparable to the area of the Great Lakes, whereas 0.6 p.p.m. may be considered effective in areas similar to Southern Arizona. For Charlotte, N. C., Stadt<sup>21</sup> reported that the concentration used depends upon the mean monthly air temperature. The amount of fluoride used varies from season to season, from a low of 0.6 p.p.m. in July to a high of 1.1 p.p.m. in January and February and the average annual level of fluoride reported by Stadt was slightly less than 0.9 p.p.m. Charlotte has used its seasonal plan without incident since 1950.

11. **OBJECTION:** Children have a greater tolerance for fluorides than adults.

**APPRAISAL:** A review of the scientific literature does not disclose any studies which would indicate that children tolerate fluorides better than adults. Several of the long-range studies, however, provide facts which are pertinent. The conclusions in the studies of Bartlett and Cameron reveal that there clearly were no more differences in medical characteristics between the people in the two cities than would be expected of two comparable cities with or without an excess of fluoride in the supply of water. The sole exception to this statement concerned dental fluorosis. Since the content of fluoride in Bartlett was 8.0 p.p.m., it far exceeded the level of 1.5 to 2.0 p.p.m. at which Dean's<sup>51</sup> epidemiological studies established that children's teeth become mottled to an esthetically objectionable degree. All of the participants born and in continuous residence in Bartlett during the formative period of teeth showed positive evidence of dental fluorosis. A similar study completed in Switzerland showed no clinically significant physiological or functional effects from prolonged ingestion of water containing excessive amounts of fluoride, except for dental fluorosis.<sup>52</sup> Thus, the available evidence from scientific studies indicates, even up to eight times the ideal amount of fluorides in drinking water, that it is tolerated equally well by adults and children, except for dental fluorosis to which the children alone are susceptible.

Knutson,<sup>50</sup> in evaluating a comprehensive study of the medical effects of fluorides, at 1.0 p.p.m., on both adults and children,

concluded that the long-term investigations revealed absolutely no indications of undesirable non-dental physiological effects which could be attributed to the fluoridation of drinking water in Grand Rapids during a period of eight years. Similar negative findings were obtained in the studies of Brantford, Sarnia Stratford, Ontario.<sup>15</sup>

12. **OBJECTION:** Small regular doses of fluorides are more damaging than large, less frequent doses.

**APPRAISAL:** The apparent premise of this objection is that fluorides have a persistent cumulative effect. Heyroth,<sup>7</sup> on the basis of his extensive toxicological studies, states that "the prolonged intake of quantities of fluorides too small to induce dental fluorosis does not give rise to any of the non-dental manifestations of chronic intoxication by fluorides. Epidemiological data and clinical and radiographic examinations of exposed industrial workers indicate that only when the fluoride content of a water supply exceeds 5.0 to 6.0 p.p.m. will its prolonged usage give rise to detectable osseous changes, and then only in the most susceptible persons."

Numerous observations have been made of groups of the population exposed for long periods to supplies of water with varying amounts of fluorides occurring naturally. In the United States more than a million people drink water with a natural content of fluoride from 1.5 to 8.0 p.p.m. No definite evidence has been produced that continued consumption of such water harms health in any way. There is no evidence that changes in the structure of bone have occurred where the supply of water contained less than 5.0 p.p.m. of fluoride.<sup>11</sup>

Balance-studies by McClure and his co-workers<sup>53</sup> led to the conclusions, when the daily intake did not exceed 4.0 to 5.0 mg., that the major portion was eliminated from the body. McClure<sup>54</sup> has determined that there are no differences in the excretion of fluoride ingested from controlled fluoridated waters and that excreted from water which contains fluoride naturally. The fluorides have identical physiological effects.

McClure<sup>54</sup> states that "upwards of 90 per cent of the fluoride ingested in most natural fluoride drinking water is eliminated from the body . . . This same efficient elimination of fluoride by the kidney must and does also pertain to fluoride ingested in fluoridated drinking water."

The major part of small traces of fluoride not excreted will be retained by calcified structures of the body. Direct epidemiological studies of children and young adults, and his other studies<sup>55</sup> convinced McClure<sup>54</sup> that

no adverse effects on skeletal tissues is produced by the presence of the trace-quantities of fluoride found in human bones. The amount of fluorides was six to eight times smaller than the amount that may be present in human bones without causing a problem of health. Hodge<sup>56</sup> has estimated that "Even if the kidneys did not excrete any fluoride whatsoever and a person drank fluoridated water for a period of 70 years, all the fluoride thus ingested would only convert a quarter of the total mineral of the skeleton to fluorapatite. Such conversions have been seen in experimental animals without evidence of loss of function or ill-health."

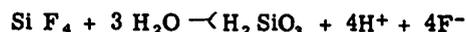
The conclusions reached in these exhaustive studies and other pertinent scientific data led the St. Louis Medical Society to state<sup>23</sup> "Let us say with confidence that we know enough of the means by which the body disposes of fluorine at levels of daily intake up to 5 mg. to predict that intakes of the order of 1 mg., over however long a period, will not cause injury to health."

13. **OBJECTION:** Fluorides form hydrofluoric acid when placed in water and this acid is a very corrosive substance used to etch glass.

**APPRAISAL:** Nichols<sup>57</sup> has explained the chemical aspects of the three compounds most used for supplementation of fluoride — sodium fluoride, sodium silicofluoride, and hydrofluosilicic acid. Nichols also discusses hydrofluoric acid as a chemical source for fluoridating water.

Sodium fluoride is prepared from calcium fluoride,  $\text{CaF}_2$ . When treated with sulfuric acid, hydrofluoric acid, HF, is formed. This HF is neutralized with soda ash or sodium hydroxide to give the sodium fluoride used in treatment of water. Sodium fluoride, as used in treatment of water, in dilute solution, ionizes as follows:  $\text{NaF} \rightarrow \text{Na}^+ + \text{F}^-$

Sodium silicofluoride, also known as sodium fluosilicate, is obtained by heating rock containing phosphate with sulfuric acid. Hydrofluoric acid forms and then unites with the silica present to form hydrofluosilicic acid which is expelled as a gas by the heat of the process. This gas is either neutralized with soda ash, or allowed to react with ordinary salt to produce sodium fluosilicate, which then settles out in the vats. This sodium fluosilicate, when used in the treatment of water, ionizes as follows:



Hydrofluosilicic acid is another compound widely used in controlled fluoridation of water.

It ionizes in a manner similar to that of sodium fluosilicate to give up all of its fluoride as fluoride ions in the water.

Hydrofluoric acid is another compound which could be used. However, it is considered somewhat difficult to handle and feed. It *ionizes in the process of supplementation of the water to give fluoride ions in a manner similar to sodium fluoride.*<sup>57</sup>

Black<sup>58</sup> states that the salts of fluorine are not present in the water but only the ions resulting from their dissociation. Whether fluorides occur naturally in the water or are placed there as a treatment of water, the ions are identical. In either situation, natural or controlled, fluoridated water in concentrations of 1 p.p.m., even when used throughout life, is absolutely safe, is beneficial and provides no harmful systemic hazards or effects in man.<sup>57,54</sup>

14. OBJECTION: Fluorides are deadly poisons in the class of arsenic, but the dangers of arsenic are better understood.

APPRAISAL: It is agreed that arsenic and compounds of fluorine are deadly poisons when used in highly toxic doses or concentrations. Arsenic is used in Paris Green and other preparations and fluorides are used, usually as cryolite, for insecticides.<sup>59,60,61</sup>

Although high dosages of fluorides are well-known to be toxic, Black<sup>58</sup> has shown that many of the other materials which people commonly use in daily life also are poisonous when improperly used or when they are used in excessive concentrations. Black cites the use of chlorine which is a deadly gas in its pure state but in proper concentration is used without question for sterilization of drinking water. Alum is used for coagulation of solids in water and the quick-lime and soda-ash used for softening water are corrosive poisons when ingested in massive doses. The spirits of ammonia and the tincture of iodine found in most home medicinal chests are corrosive poisons. Many medicines used for the cure of diseases are deadly poisons.<sup>54</sup> Even common table salt, in large amounts, is poisonous.<sup>62</sup>

Black<sup>54</sup> concludes, when one calls a substance a poison, that it is necessary to specify the conditions under which it is used. In the concentration of 1.0 p.p.m. employed for fluoridation, none of the compounds of fluoride will produce toxic effects, with the possible exception of unobjectionable dental fluorosis of the enamel in a small percentage of children. Dean<sup>35</sup> has described the condition as "no more than sporadic instances of the *mildest type of fluorosis without practical esthetic significance.*"

The personnel of the St. Louis Division of

Health<sup>63</sup> have repeatedly pointed out the highly pertinent consideration that they recommended for the city of St. Louis "the addition of a *trace* of fluorine — one part of fluorine to one million parts of water — and not 2-, 3-, or 50 or any other amount." Likewise, the crux of any scientific discussion of fluoridation must relate directly to the quantity of fluoride actually prescribed for use.

According to Leone,<sup>37</sup> the toxic dose in human beings would approximate 4.0 to 5.0 grams, if administered intravenously. Leone has pointed out that this quantity is 16,000 to 20,000 times the trace amount contained in an eight-ounce glass of water fluoridated at 1.0 part per million. The importance of these observations again is emphasized by Leone<sup>37</sup> when he stated that the intravenous dosage is even more significant pharmacologically in view of the finding that an oral dose of most toxic substances is twice that required in the intravenous dose. All available evidence clearly demonstrates a tremendous margin of safety in the use of water fluoridated to a concentration of 1.0 p.p.m.

15. OBJECTION: Fluorides are by-products of aluminum, a harmful material used for cooking utensils.

APPRAISAL: It appears immaterial and irrelevant to discuss the industrial source of the fluorides used in the treatment of water. It is well-known that fluoride compounds are highly toxic when used in high dosages or concentrations.<sup>59,60</sup> Some of the major sources of compounds of fluoride include fluorite (fluorspar), cryolite, fluorapatite, certain igneous rocks and sedimentary limestone rocks. Sodium fluoride is prepared usually from the mineral fluorspar. Sodium silicofluoride and hydrofluosilicic acid are produced as a subsidiary operation to the production of phosphate fertilizers. All are produced by chemical companies,<sup>57</sup> but the compounds of fluoride used for fluoridation of water are not a by-product of aluminum plants.<sup>62</sup>

The important point to discuss is not the source of the chemical but the manner and concentration in which the chemical is used. The basic question has been stated numerous times, namely, does or does not the use of water fluoridated to 1.0 p.p.m. provide benefits without damage to the human organism? No data as evidence have been provided to substantiate charges that fluoridated water, *as recommended for the purposes of dental health*, either causes harmful systemic effects or is without benefits. There is plenty of evidence to justify Dean's<sup>35</sup> conclusion that "fluoridation is a proven effective, cheap and safe method for the partial control of dental caries."

16. **OBJECTION:** An accident in the water plant might cause over-dosage and severe, harmful effects.

**APPRAISAL:** Hodge and Smith<sup>3</sup> used a simple arithmetic procedure to discuss the possibilities of accidental over-dosage. They state that "If a day's supply (of fluoride) were delivered over a period of one hour the water would contain only 24 p.p.m. and this amount could be taken daily for 10 years without serious difficulty. Furthermore, for a city like Rochester, New York, to add to its supply of water a sufficient amount to be acutely toxic, i.e., deadly, a total of 400 tons of fluoride would have to be added to the volume of water distributed daily to the city. The machine in Rochester that adds fluoride to the water has a hopper which contains 1000 lb.; an acute poisoning is mechanically impossible."

Cox and Ast<sup>1</sup> have shown that acute morbidity, manifested by salivation and vomiting, may be caused by ingesting 0.25 g. of sodium fluoride. This quantity in an eight-ounce glass of water represents 1000 p.p.m. of sodium fluoride or about 450 p.p.m. of fluorine. Four tons of sodium fluoride, or more, per million gallons of water processed, would be required to obtain this concentration. Even gross negligence would not make this error possible in a program of fluoridation.

Leone<sup>37</sup> demonstrated, when single toxic doses of 3000 mgs. of fluoride were given to animals, that it was not possible to produce fatal poisoning. The irritating effect of toxic concentrations of fluorine produces nausea and vomiting which protects the animal. This observation, according to Leone, has a practical value related directly to the introduction, accidentally or through faulty equipment, of large amounts of fluoride into the drinking water. Apparently it is not possible to retain the massive overdosage even if it were mechanically possible to get a fatal dose into the water mains. Heyroth<sup>7</sup> sums up the concensus of the various investigators by stating, "It is evident that there need be no fear of the occurrence of acute poisoning as a result of the accidental or deliberate overfluoridation of a water supply."

17. **OBJECTION:** Adding fluorides to water may present a hazard to workers in the water-plants.

**APPRAISAL:** The mechanics of feeding fluorides, except hydrofluoric acid, are no more complex than those for feeding other chemicals used in the purification of water.<sup>34</sup> Safeguards against inhalation of powdered chemicals and against corrosive solutions are provided routinely for workers in plants during the treatment of water. Dust-masks and rubber gloves are standard equipment where dry chemicals

are used. Complete external protection is used when working with equipment for using hydrofluoric acid. Use of rubber aprons and rubber gloves minimizes contact with other solutions such as hydrofluosilicic acid and sodium fluoride. Installation of collecting equipment and exhausts for dust is to be used in all large installations for dry-feeding where dust cannot be controlled otherwise.<sup>65</sup>

Operators in plants have reported that no serious problems of operating are encountered and, under proper precautions, that fluoridation appears to be no more hazardous to personnel than is chlorination.<sup>62,66</sup>

Frye and Hill<sup>67</sup> reported a statement, by the Superintendent of the Water Department at Evanston, Illinois, that "Application of sodium fluoride at Evanston has caused less maintenance and operating difficulty than any other water-works chemical."

18. **OBJECTION:** Fluorides endanger especially those people who drink large quantities of water.

**APPRAISAL:** It would not be possible for people to endanger their health or their lives by drinking excessive amounts of water which contained 1 p.p.m. of fluorine. Leone<sup>37</sup> has shown that, to consume the 4.0 to 5.0 grams which are recognized generally as providing the toxic dose, it would be necessary to drink 16,000 to 20,000 times the trace-amount contained in an eight-ounce glass of water fluoridated at 1.0 part per million. Obviously, it would be impossible to ingest the thousands of glassfuls necessary to obtain the toxic dose.

It is recognized<sup>36</sup> that individuals vary in their consumption of water. Therefore, in evaluating the safety of fluoridation, insofar as mottled enamel is concerned, consideration must be given both to average and above average consumption of water. It is estimated that the average adult consumes about one quart of water per day. Thus, if the water contains 1.0 p.p.m. then the average adult consumes about 1 mg. of fluorine per day beyond the 0.3 to 0.5 mg. contained in his food. It must be emphasized that the two-fold margin of safety in connection with mottled enamel, as stated by Hodge and Smith,<sup>3</sup> is not based on average water consumption. Rather it refers to findings among many thousands of people representing the complete range of intake of water.<sup>36</sup> According to all available evidence and experience the prediction can be made that unesthetic mottling will not develop.<sup>3</sup> The Board of Health of New York City has stated that disfiguring mottling does not occur, even among those of the population consuming the most water.<sup>38</sup>

Galagan and Lamson<sup>18,19</sup> found that children reared in areas with mean annual

temperatures of 70° F. consumed approximately twice as much water as children living in areas with mean annual temperatures of 50° F. They recommended that mean annual temperature be used as a practical measure to adjust concentrations of fluoride to climatic conditions. Specifically, they recommended that 1.0 to 1.2 p.p.m. be accepted as the optimum in zones comparable to the area of the Great Lakes, whereas 0.6 p.p.m. may be accepted as equally effective in areas such as Southern Arizona.

In summary, Hodge and Smith<sup>3</sup> and Leone<sup>37</sup> have shown that the possibility for acute fatal poisoning is nil. However, studies concerning the relationship of temperature to mottled enamel<sup>18,19</sup> have shown that areas with high mean annual temperatures require reductions in concentrations of fluoride to less than 1.0 p.p.m. in order to avoid possibilities of causing unduly high percentages of slight dental fluorosis.

19. OBJECTION: Fluorides in "smog" settle on leaves and poisoning results when these leaves are eaten by cattle.

APPRAISAL: Problems of pollution of air, arising from various toxic industrial by-products, including fluorides, are serious problems. However, there is no more relationship between the problem of toxic fluorosis, produced by contaminants in the air, and the use of a trace of 1.0 p.p.m. than there would be between the use of toxic chlorine as a war-gas and the use of chlorine in trace amounts for disinfection of water. The objection simply does not relate to the fluoridation of water as a measure to protect health.

It is well-known that "fluorides carried through the air and deposited on pastures and fields of forage crops pose a hazard to livestock fed on such grass or forage."<sup>58</sup> Huffman<sup>69</sup> states that fluorine toxicosis may result from such air pollution. Among the symptoms, Huffman mentions dental fluorosis and bony lesions. Dairy cattle are more susceptible than beef-breeds. The effects in livestock of excessive fluorine intake deepens, depending upon the level of intake, the duration of the feeding period and the class of animal involved.<sup>69</sup> Cattle and sheep are the most frequent victims.<sup>68</sup> The extent of the contaminated area depends on volume of fluoride-effluents from industrial plants, the form of the fluoride, and meteorological factors.<sup>7</sup> Huffman states<sup>69</sup> that forage-contamination sufficient to cause slight dental fluorosis in cattle may occur at a distance of seven miles or more in the direction of the prevailing wind." The amount of fluorine secreted with milk is not considered significant," and "milk or meat obtained from such animals

is not likely to be injurious because fluorine poisoning is primarily a condition which affects teeth and bones."<sup>69</sup> Slight dental fluorosis without excessive wear does not affect the general health of animals, according to Huffman.<sup>69</sup>

The control of such pollution of the air lies in reducing the effluents of fluorides from manufacturing plants. Some industries are installing equipment designed to achieve this reduction.<sup>69,62</sup>

While the matter of pollution of air by the various gases, which include toxic concentrations of fluoride, is of importance and interest, it has no bearing or relevancy to the use of tiny amounts at levels of 1 p.p.m. for fluoridation of water.

20. OBJECTION: Sodium fluoride is 8500 per cent more deadly than calcium fluoride which is the naturally occurring form in supplies of water.

APPRAISAL: The question "Is there a difference between 'natural' and 'artificial' fluoride ions?" was answered in a formal statement signed by 132 of the foremost chemists in the United States.<sup>71</sup> The chemists stated that scientists do not manufacture fluorine or fluorides commercially from other elements, but use naturally occurring materials from which to separate the well-known fluorides used in commerce.

The element, fluorine, is one of the common naturally occurring elements which constitute the earth's surface. It occurs naturally in all river and well water, but in widely varying amounts. It is present in the form of fluorides which are composed of fluorine combined with another element or group of elements. In these combinations each atom gains one electron and the new substance is called a fluoride.<sup>71</sup>

Waters naturally containing fluoride ions obtain their supply by contact with minerals in or on the earth's crust by dissolving the minerals containing the fluoride compounds. These mineral fluorides almost all ionize, when present in very dilute solution in water, to form fluorine ions. All compounds used in the fluoridation of water are obtained from minerals found in nature. When these compounds are used in fluoridation of water they yield ions of fluorine identical in every respect with those found in natural waters; this chemical dissociation is to be expected since the fluorides used, as has been stated, are obtained from deposits of mineral.<sup>57</sup>

Nichols<sup>57</sup> stated that calcium fluoride, CaF<sub>2</sub>, is the naturally occurring mineral used to prepare sodium fluoride. When the calcium fluoride is treated with sulfuric acid, hydrofluoric acid, HF, is formed. Then the hydrofluoric acid is neutralized with soda ash or sodium hydroxide to give the sodium fluoride used

side-reactions, than was known about fluoridation of water. I know of no procedures, including water chlorination, pasteurization of milk, or vaccination against small pox, which has had the intensive and comprehensive study before it was applied as water fluoridation has had."

The Bartlett and Cameron<sup>10</sup> studies demonstrated, even with about eight times the optimal amount of fluoride present, that "No clinically significant physiological or functional effects resulted from prolonged ingestion of water containing excessive fluoride, except for dental fluorosis." A similar study completed in Switzerland also yielded negative findings.<sup>52</sup>

The consensus of scientific opinion concerning the safety of fluoridation was stated by Baumgartner and others<sup>36</sup> in an official report on fluoridation to the Mayor of New York City. The statement reads, "The evaluation of the available scientific data, both theoretical and clinical, fails to reveal any threat of harm to even a small proportion of the population consuming water fluoridated at the 1 p.p.m. level. It is established further that these scientific data are so extensive and broad in scope as to establish the safety of the procedure beyond a reasonable doubt. There is no known measure for the protection of health which has been subject to as much investigation prior to adoption as has the fluoridation of water."

25. OBJECTION: Fluorides impair the proper metabolism of carbohydrates, fats, and proteins.

APPRAISAL: Fluorine is present in numerous places in soils and in plants, used for food by man. The average adult receives about 0.3 mg. per day in his food; it is present in soft tissues and fluids, but particularly in the skeletal tissues. Individuals consuming an average diet and using a domestic supply of water containing 1.0 p.p.m. of fluorine will receive from 0.4 to 1.4 mg. per day in adult life.<sup>78</sup> Based on McClure's<sup>79,80,81</sup> studies, Russell has concluded that "... it seems quite likely that the average adult daily ration, anywhere in the United States, contains about 0.3 mg. of fluorine."

It is essential to consider that over a million people in the United States served by 453 different water supplies, have used drinking water for generations with a natural fluoride content of 1.5 to 8.0 p.p.m. No definite evidence has been forthcoming that continued consumption of such water was in any way harmful to health. The literature contains no data to support an assertion that ingestion of fluorides impair the metabolism of food.

There is voluminous and substantial evidence that fluorides in recommended dosages,

and even in concentrations up to 8.0 p.p.m. cause no harmful systemic effects.<sup>10,11,15,16,22</sup>

It has been established as fact that fluorides have been ingested, as common elements of food and water, by millions of people over many generations. McClure<sup>82</sup> studied the relationship of the use of fluoridated water to the height, weight and experience with fractured bones of 1458 high-school boys and 2529 young men at the centers for induction into the Armed Forces. He concluded that the average height and weight of all of the boys compared favorably with other height-weight data and accepted standards. He found no relationship between height and weight and exposure to fluorides.

The data indicate that the metabolism of the food of these males apparently was equally satisfactory in fluoride and non-fluoride areas. Another consideration is that impairment of the metabolism of proteins, fats, and carbohydrates has never been reported as a specific finding in any of the numerous scientific studies. No reports have been published to indicate that Americans in cities drinking fluoridated water, either natural or controlled, either are underweight or suffering any other effects of malnutrition.

26. OBJECTION: Fluorides are cumulative poisons. Their effects may not be noticed for 20 years or longer.

APPRAISAL: It is true that all of the compounds presently used for the fluoridation of water have long been known as poisons, *when ingested in massive doses*.<sup>58</sup> It is true also that chlorine, alum and soda ash are all corrosive chemical poisons employed in the treatment of water. However, like fluorides they must be used in proper concentrations to produce their benefits with safety and efficiency. It is well-known that drugs and medicines are often highly poisonous when used in excess dosages.<sup>52</sup> Hodge and Smith<sup>3</sup> have pointed out that there is no possibility of acute fatal poisoning when using water fluoridated at 1.0 p.p.m.

Heyroth<sup>7,83</sup> has mentioned four sources of evidence for the safety of fluoridation of public supplies of water including (1) animal, (2) volunteer human experimentation, (3) epidemiological studies of the health of residents of communities whose water bears excessive amounts of fluorides, and (4) the results of medical examinations of personnel exposed to fluorides in industry.

Heyroth cited studies which concerned the health of persons who have lived to advanced ages where the water contained from natural sources more than 1 p.p.m. No evidence was

found of skeletal fluorosis in radiographs of 31 persons who had lived for 18 to 68 years at Bureau, Illinois, where the water contained 2.5 p.p.m. of fluoride, or in those of 86 residents of Kempton, Illinois where the content had varied between 1.3 and 3.0 p.p.m. Heyroth also cited examinations of 50 persons in Lake Preston, S. D., where the water contained 6.0 p.p.m. of fluoride. He stated that "all four lines of evidence lead to the conclusion that fluoridation of water to 1.0 p.p.m. provides an ample margin of safety."

Further studies by Leone and his associates<sup>10</sup> have provided additional corroborative data and conclusions.

Heyroth<sup>83</sup> found that an increase in the density of bone may be detected at a daily intake of about that found in drinking water containing 5.0 or more parts per million. Leone<sup>37</sup> found, *even at 8.0 p.p.m.*, that "no clinically significant physiological or functional effects resulted from prolonged ingestion of water containing excessive fluorides, except for dental fluorosis.

Leone,<sup>84</sup> reported that a radiologic survey of 114 persons at Bartlett, Texas, where the water contained 8.0 p.p.m. of fluoride, revealed minimal evidence of an increase in density of the bones of 12 per cent of those examined, but in none was there deformity or interference with skeletal function. These 114 persons had lived for at least 15 years in Bartlett. Leone<sup>37</sup> also reported that "a most unusual finding was the evidence of beneficial adult bone effect in counteracting the osteoporotic changes in the aged; hip fractures, a common occurrence to aging groups, was absent in the high fluoride area."

The statement that fluorides are cumulative poisons has not been substantiated. Also no evidence or studies have been presented for scientific evaluation to indicate that fluorides have produced harmful effects on the health of any person. Even though millions of people have drunk, throughout their lives, water fluoridated far beyond the trace quantity recommended for dental health, no evidence of injury has been observed, with the exception of mottled enamel, which occurred in areas using water containing excessive quantities of fluoride.<sup>22</sup>

27. **OBJECTION:** Fluoridation of water is an additional hazard to individuals who experience occupational exposure to fluorides.

**APPRAISAL:** Heyroth<sup>83</sup> has reported that medical studies of men exposed to an atmosphere contaminated by fluoride have been made to establish the safe level of the industrial environment. On comparing their radiographic findings and urinary output with those of

persons who acquire their fluoride from water, it was found that an increase in density of the bone may be detected at a daily intake of about that which corresponds to the use of drinking water with 5.0 or more parts per million.

Workers exposed to such excessive concentrations of fluoride in their occupations that their health is threatened, or actually involved, should have direct protection by industry from such serious dangers. The protection of these people from toxic fumes, vapors, or dusts is a highly important and proper function of industrial hygiene and preventive medicine. The ingestion of trace amounts of fluorides in water at the recommended level of 1.0 p.p.m. would contribute only an insignificant amount of fluoride.

Hodge and Smith<sup>3</sup> stated that 1.0 mg. is ingested daily by an adult who drinks a quart of water fluoridated at 1.0 p.p.m.

Potential hazards of operations in water plants through the handling of fluorides have been recognized. Personnel are protected against inhalation of toxic powdered chemicals and against contact with corrosive solutions. Dust masks and rubber gloves are standard equipment. Complete exterior protection is used when working with equipment adding hydrofluoric acid. The concentration of fluoride in the air must be less than 2.5 mg. per liter, which is the established allowable exposure over an 8-hour day, five-day week. In addition, installation of equipment for collecting and exhausting dust is recommended for both large and small dry-feed installations, when dusting cannot be controlled by other means.<sup>65</sup>

No studies have been presented to indicate that the small amounts of fluoride required to fluoridate drinking water produces ill effects of any kind or constitute a hazard to personnel working with fluorides in industry.

28. **OBJECTION:** Fluorides affect the genes and will bring about undesirable alterations in the second and third generations.

**APPRAISAL:** Doty<sup>22</sup> has pointed out that nearly four million residents of the United States use water which, for many years, has carried adequate or excessive amounts of fluoride. Over 31 million others<sup>38</sup> in 1957 were receiving water whose fluoride was adjusted to a physiologic level.

Smith and Hodge<sup>3</sup> stated that in areas of the country where drinking waters naturally are fluoridated, large populations have been exposed for generations to fluorides with no readily-evident ill effects, except mottling of the enamel, even when more than 2.0 p.p.m. of fluoride were present. The growth of individuals in these areas was demonstrated as normal.

McClure<sup>82</sup> found that the average height and weight of boys and young men in the fluoride-areas compared favorably with the accepted standards and with those persons from similar groups in non-fluoride areas.

An extensive search of the literature fails to reveal any studies, data, or scientific evidence of any kind to indicate that the objection is founded on facts.

29. **OBJECTION:** Fluorides serve as a causative factor in viral infections by interference with the development of immunity.

**APPRAISAL:** A review of scientific literature reveals no data or studies to substantiate a belief that fluorides in drinking water in concentrations recommended for dental health interfere with immunological processes or have any bearing on viral diseases.

Doty<sup>22</sup> has pointed out that for many years approximately four million people in the United States have drunk water which was fluoridated by nature at concentrations ranging from 0.7 to 3.0 p.p.m. Special studies lasting ten years were conducted by Leone and his co-workers<sup>10</sup> at Bartlett, Texas, where the water contained 8.0 p.p.m. of fluoride. No findings relating fluorides to viral diseases or immunological failures were revealed.

No studies have been presented which indicate that immunizations have failed in areas which have been using fluoridated waters. The literature does not report epidemics or unusual rates of viral diseases for cities which have used fluoridated drinking water.

30. **OBJECTION:** Individuals may absorb excessive amounts of fluoride by osmosis while bathing in fluoridated water.

**APPRAISAL:** A search of the scientific literature does not reveal a single instance of harmful effects which arose from bathing in fluoridated water. However, there have been studies which have developed information relating to the objection.

Leone<sup>85,37</sup> has produced evidence that an appreciable amount of fluoride has to be consumed in order to produce deleterious effects. The data developed by Leone and his co-workers indicate that the toxic dose would be approximately four to five grams, *if administered intravenously*. This amount is 16,000 to 20,000 times the trace contained in an eight-ounce glass of water. Hodge and Smith<sup>3</sup> presented a table in a chapter of a publication by the American Association for the Advancement of Science which illustrates the margins of safety existing between the intake of fluorides as recommended for dental protection and each of the four possible toxic effects from

an overdose of fluoride. The factor of safety against *drinking* enough water, fluoridated at 1.0 p.p.m., to cause fatal poisoning is 2500 times. An official statement signed by leading American authorities has been included in a formal report<sup>86</sup> concerning fluoridation's safety. Using the Hodge and Smith table, just mentioned, these experts concluded that "For any person to become poisoned from drinking fluoridated water at one part per million, that person would have to drink at least fifty bathtubs full of water. Long before that, the person would die of water intoxication or drowning."

Since ingestion of all the fluoride at a concentration of 1.0 p.p.m. would tend inevitably to produce a much more significant result pharmacologically than bathing, it obviously is impossible for persons to be injured by the absorption of fluorides from fluoridated drinking water used for bathing purposes.

31. **OBJECTION:** Public health personnel use non-comparable data to demonstrate the safety of fluoridation.

**APPRAISAL:** Comparability of data is without doubt highly relevant to the acceptance of the conclusions which result from scientific studies. In order to have data that are comparable it is essential that the subjects in the group studied and those in the group serving as the control either will be comparably similar or that required adjustments be made to ensure scientific comparability of the data. Noncomparability in the relevant factors must be identified and either eliminated or adjusted prior to making professional interpretations. A sizable number of persons usually must be selected if the comparisons are to reach a high range of confidence for validity.

An examination of the published reports of the scientists of the Public Health Service indicates that comparability of data has been one of their major cares in designing their projects, collecting and summarizing their data, adjusting for statistical comparability, and in their interpretations of results.

For example, Leone and his co-workers<sup>10</sup> reported details of a 10-year study in Bartlett, Texas. The study had definite design and purpose. The recognition of their need for comparable data is pointed out and the meticulous efforts taken to achieve comparability is described in detail. Comparability was sought and achieved deliberately in obtaining and analyzing data. A statistician was among the co-authors of the report. Other reports,<sup>87,84</sup> based on clinical findings, were planned and completed with similar attention to high standards of comparability.

Arnold, Dean, Jay, and Knutson<sup>17,88,50</sup> designed and carried out the project of fluoridation

at Grand Rapids with the most meticulous attention to development and analyses of comparable data. The pioneering epidemiological studies of Dean,<sup>51</sup> McClure's comprehensive studies<sup>28,82</sup> concerning the systemic effects of fluorides, and the extensive study by Hagan, Pasternach and Scholz<sup>12</sup> of the 32 pairs of American cities are only a few of the many investigations performed by the U. S. Public Health Service which illustrate the highest standards for excellence of design, collection of comparable data and statistically acceptable methods of analysis.

32. OBJECTION: Fluorine is an essential ingredient in nerve gas.

APPRAISAL: The use of fluorine, chlorine or any other substance in massive quantities for wartime weapons has no relevancy to its use in tiny traces. Toxicity in fluorides is not qualitative. Armstrong<sup>69</sup> has pointed out that misunderstandings have arisen because very large amounts of fluoride are toxic. He explains that it is impossible to state categorically that any substance is a poison without defining the amounts of the substance or the conditions of its administration. This caution applies to fluorides. Numerous substances, including many required by the body, are toxic when taken in large amounts. For example, the essential vitamin D may produce toxic effects when taken in careless overdoses. Citing a gas as an example, oxygen forms 21 per cent of the air that is breathed. If an animal breathes pure oxygen, particularly under pressure, it will suffer ill effects, and if the experiment is continued long enough the animal surely will die. Under these specific conditions, oxygen is a poison.

The issue, then, is not whether or not pure fluorine or chlorine has been used in amounts sufficient to serve as a weapon of warfare. The issue is whether fluoridated drinking water, containing the recommended level of approximately 1.0 p.p.m., will be beneficial and safe. All evidence indicates, in the words of Dean,<sup>35</sup> that "fluoridation is a proven, effective, cheap and safe method for the partial control of dental caries."

33. OBJECTION: Fluoride passes through the placenta of the mother and poisons the developing fetus.

APPRAISAL: Roholm<sup>24</sup> studied the teeth of five children of workers in a Danish cryolite factory; the parents had been exposed to toxic concentrations of fluorides over a long period of time as an occupational hazard. He concluded that "the normal enamel of the deciduous teeth was a sign that fluorine does not

pass the placenta." Roholm also stated that "the circumstance that the examination of two of the infants showed no roentgenologically recognizable bone changes points in the same direction."

Hodge and Smith<sup>3</sup> suggest two mechanisms whereby fetuses and newborn babies appear to be protected. They cite Gardner and others<sup>80</sup> who stated that the placenta has been found to contain many times the fluoride in the circulating blood. Hodge and Smith<sup>3</sup> state that "placentae obtained in communities where the drinking water is fluoridated have higher fluoride concentrations than those in communities with no fluoride in the drinking water. How the fluoride is held in these organs is not known, and whether the placenta really constitutes a barrier between the mother's blood and the fetus has not been established. The high concentration of fluoride suggests a protective role."

Gardner and his co-workers<sup>80</sup> have recalled, since excessive amounts of fluorine are toxic, that the placenta may be serving as a barrier to prevent more than traces of fluorine from reaching the fetus. Animal experiments by Knouff<sup>91</sup> provide supportive evidence. Fluoride in a concentration of 5.0 p.p.m. was administered to dogs during the last eight weeks of gestation. The fluoride did not reach the fetuses in concentrations sufficient to be detected and the fetal teeth showed no marked difference from normal teeth.

A part of the medical aspects of the study in Newburgh and Kingston<sup>77</sup> related to babies. Comparisons were made of the stillbirth and the rates for maternal and infantile mortality in Newburgh and Kingston for a period starting five years before the initiation of fluoridation and during the 10 years of the study. Although the relatively small numbers available permitted considerable variation in the rates for mortality, the long-term downward trends were similar in the two cities and there was no detectable change in the trend in Newburgh after fluoridation. No differences of medical significance could be found between the group of children from the fluoride-city of Newburgh and the group from the fluoride-free city of Kingston.

The St. Louis Medical Society,<sup>23</sup> using data supplied by the Wisconsin Board of Health, studied the relationship of deaths of pregnant women and of babies before and after birth to the amounts of fluorine of the water in their Wisconsin communities during two successive five-year periods. The Society concluded that "The well-recognized stresses of pregnancy and the sensitiveness of the developing fetus to changes in its environment could be expected to reflect toxicity if any were produced by the water. Yet *there is no important or consistent*

*difference in the frequency of deaths* at term (stillbirth), immediately after delivery (neonatal), during the first year of life (infant), or in the mothers themselves in the cities whose supplies of water contained from 0.03 to 2.5 p.p.m. of fluorine. There was no significant alteration of these patterns in the city of Sheboygan during the five-year period following the raising of its concentration of fluorine from 0.03 to 1.2 p.p.m.

The available evidence seems to indicate that there is no toxic effect, from drinking water fluoridated to physiologic concentrations of approximately 1.0 p.p.m., on either the mother or the child.

34. **OBJECTION:** Some of the basic and necessary metabolic processes in cells are stopped by a concentration of fluoride in the body.

**APPRAISAL:** Several of the preceding appraisals have pointed out that dosages and concentration control the results produced by chemicals or drugs. This observation also maintains for fluorides.

It has been stated by Dean<sup>92</sup> that endemic dental fluorosis, characterized by a hypocalcification of enamel, occurs when excessive amounts of fluorides are ingested in drinking waters. Smith and others<sup>93</sup> had proved that fluorine caused mottled enamel or endemic dental fluorosis. Dean and Elvove<sup>94</sup> then established the threshold of safety from fluorosis to be 1.0 p.p.m. of fluoride. A quantitative relationship also was reported between the amount of fluoride in the water and the severity and extent of mottled enamel resulting from ingestion of the water.

However, the National Research Council<sup>95</sup> stated that "the margin between the optimal quantity of fluoride in drinking water which is required for maximal benefit in tooth development and the amount which produces undesirable physiologic effects is sufficiently wide to cause no concern."

The studies<sup>10</sup> in Bartlett and Cameron demonstrated, except for mottled enamel, that concentrations of fluorides up to 8.0 p.p.m. produced "no clinically significant physiological or functional effects" from prolonged (10 years) ingestion of the water. The medical studies of Newburgh and Kingston,<sup>77</sup> the studies in Grand Rapids,<sup>17,50</sup> and the study in Brantford, Ontario<sup>15</sup> produced the same findings — no harmful effects from water fluoridated at about 1.0 p.p.m.

Moreover, the human body has protective mechanisms against harmful concentrations of fluorides. McClure and Kinser<sup>28</sup> demonstrated the positive correlation between the fluorine ingested in drinking water and the fluorine excreted in urine. Other studies by

McClure and associates<sup>53</sup> led to the conclusion that, unless the daily intake exceeds four to five mg. fluorides are eliminated almost entirely from the body by the urine and perspiration. To consume such an amount of fluoride, it has been computed<sup>11</sup> that a person would have to drink about five quarts of water containing 1.0 p.p.m. of fluorine.

In addition to the efficient excretion of fluorides in urine, the body has another important protective mechanism. Residual fluoride, not excreted, is stored in the skeletal system, bones and teeth. Little, if any, remains in soft tissues or the organs. No functional disadvantages and no evidence of changes in bone have been reported when water contains no more than five p.p.m. of fluoride.<sup>11</sup> Twelve per cent of those examined in Bartlett (8.0 p.p.m. of fluoride) showed minimal radiographic evidence of increased density of bone. Not one person in the group, however, had any deformity or interference with function.<sup>10</sup>

Schlesinger<sup>77</sup> who conducted medical examinations in the 10-year study of Newburgh and Kingston concluded that "There has been no indication of any systemic effects, adverse or otherwise, from the use of fluoridated water on the basis of the Newburgh-Kingston findings."

The scientific literature provides no evidence to indicate that fluorides ingested with drinking water, containing fluoride at about 1.0 p.p.m., will produce harm to the metabolic processes of cells or tissues. There is ample evidence to the contrary as indicated in the studies cited.

35. **OBJECTION:** Fluorides form compounds with the calcium of the blood and interfere with the normal metabolism of calcium.

**APPRAISAL:** Heyroth<sup>7</sup> has reported that calcium is decreased only slightly, if at all, in chronic poisoning. Jodlbauer<sup>96</sup> has reported that blood-calcium may be lowered by about 50 per cent *in acute poisoning*. Rabinowitch<sup>97</sup> also has reported a patient who achieved suicide by ingestion of sodium fluoride. He exhibited spasms of the hands and feet and died of respiratory failure about three hours after taking the fluoride. A sample of blood taken a few minutes after death contained 2.6 mg. of calcium per 100 ml. of serum, thought by Rabinowitch to be the lowest ever observed in man. The normal for blood-calcium is 9.0 to 11.5 mg. Cox and Hodge<sup>8</sup> have stated that absorbed fluoride forms strong complexes with calcium. They state, also, that low blood-calcium may be the basis for the muscular spasms which are observed in severely poisoned individuals.

The toxic effects described by these investigators are not produced by the traces of

fluorides used in water to secure the amounts recommended for fluoridated water. This lack of toxicity has been demonstrated by studies both of animals and human beings. Heyroth<sup>7</sup> concluded from animal experiment that interference with growth cannot be induced by a daily intake too small to give rise to dental abnormalities. The medical aspects of the various long-term projects of fluoridation at Bartlett and Cameron, Texas,<sup>10</sup> Grand Rapids and Muskegon, Michigan, and Aurora, Illinois,<sup>17,50</sup> Brantford, Ontario,<sup>15</sup> and Newburgh and Kingston, New York,<sup>16</sup> all have included studies of the blood. No findings of harmful effects of any kind have been found.

The affinity of fluorine for calcium and magnesium theoretically, makes it possible for fluorine to interfere with the body's system of enzymes. According to a carefully studied-out report by Baumgartner and others<sup>98</sup> there is every assurance that 1.0 p.p.m. of fluoride in water represents a concentration of about 1/100th of that which might interfere with these enzymes. All evidence indicates that the body cannot concentrate fluoride, from such a concentration, so as to reach a harmful level. There is, accordingly, a large margin of safety.<sup>98</sup>

36. OBJECTION: Water containing 1.0 p.p.m. of fluoride may contain as much as 35 p.p.m. after boiling.

APPRAISAL: The available literature indicates that a single dose of 5.0 to 10 grams or 5,000 to 10,000 mg. of sodium fluoride is the minimum required to produce fatality. This dosage represents, according to Hodge and Smith,<sup>3</sup> from 2,500 to 5,000 times the amount of fluoride that is contained in a quart of water fluoridated at 1.0 p.p.m. Baumgartner and others<sup>98</sup> have reported computations showing that a seven-year supply of fluoride would have to be dumped into the water in an instant to produce such a dangerous level of fluoride. Any hazard to health posed by fluoridation of water would have to arise from the cumulative effects of small amounts ingested regularly over long periods of time *rather than by the acute effects of a single dose.*

The body's mechanisms of excretion of most of the fluoride and storage of the residual traces have been described by Hodge and Smith<sup>3</sup> and by McClure.<sup>5</sup> The studies at Bartlett, Texas, show, even over a period of many years, that fluorides at the level of 8.0 p.p.m. cause no systemic damage, except for mottled enamel.

The boiling of water for purposes of cooking was practiced by the residents of each city where long-term projects of fluoridation were conducted. The scientific reports include

findings which resulted from the most meticulous medical examinations. Thus the evidence is direct and positive that damage to people was not detected despite repeated and periodic medical examinations.<sup>10,17,50,15,16</sup>

Further evidence of the safety of water containing 1.0 p.p.m. is available on an empirical and practical basis. Over 31,000,000 persons in the United States in 1492 communities now drink fluoridated water, and boil this water to do their cooking. No one has ever presented evidence that damage in any way has resulted. There is ample evidence that the water fluoridated to 1.0 p.p.m. is safe for drinking and for cooking purposes.

37. OBJECTION: Fluorine ions distort the metabolism of the body and make the individual more susceptible to every known disease.

APPRAISAL: Hodge and Smith<sup>3</sup> have discussed the four toxic effects of fluorides and pointed out human safety in connection with fluoridation of drinking water. Table 1 illustrates their conclusions:

Table 1<sup>3</sup>

Toxic Effect	Amount of F.	Factor of Safety
Acute fatal poisoning	5-10 g.	2500 X
Growth-depression	50 or more p.p.m./day	50 X
Osteosclerosis and x-ray	8-20 or more mg/day	8-20 X
Mottled enamel	2-8 or more mg/day	2 X

There is no possibility of acute fatal poisoning. Children, drinking fluoridated water, will grow normally. No detectable alterations will occur in the structure of bone. Although only a two-fold factor exists in the instance of mottled enamel this response in large groups of children has been so closely related to dosage that it can be predicted with confidence that unesthetic mottling will not be seen.<sup>3</sup>

No evidence has been presented which would serve to substantiate the objection. However, there is ample scientific evidence, based on conclusive long-range studies, which demonstrates that fluoridation is beneficial, effective and free of harmful effects when used in proper concentrations for optimal dental health. These studies include statistical analyses,<sup>13,14</sup> animal experimentation<sup>3,7,29,83</sup> and numerous projects which dealt directly with people.<sup>10,15,16,17,50,77,78,87,99</sup>

The Commission on Chronic Illness,<sup>11</sup> after reviewing the existing studies, urged that American communities adopt fluoridation as a positive step in preventing the chronic disease, dental caries.

scientific evidence suggesting fluoridation was much more complete 10 years ago than has been the scientific evidence for the majority of health programs when they started. I refer particularly to the chlorination of public water supplies, the pasteurization of milk supplies and immunization against smallpox, diphtheria and other infectious diseases."

Scientists are the first group to admit the need for new knowledge and to seek it. Dental scientists have completed numerous studies, concerning the metabolism of fluorides — many of them very extensive. Bronk,<sup>104</sup> has indicated the validity of their contributions by stating "As President of the National Academy of Sciences I have full confidence in the integrity, reliability and scientific competence of these (fluoridation) reports."

The literature dealing with the metabolism and toxicology of compounds of fluorine has been evaluated by the Commission on Chronic Illness. In a special report on fluoridation, the Commission<sup>11</sup> stated, in its judgment, that "there has been a sufficient number of observations on human subjects, with support of animal experiments, to establish the pattern of metabolism." The report covers the findings and conclusions on toxicology and metabolism by Heyroth<sup>7</sup> and McClure and Kinser.<sup>28</sup> Reports by these and other investigators<sup>2,3,8,23,24,33,41,51,53,55,56,57,72,73,74,75,76,80,81,82,83,85,90,93,94,95,96,97,99,100,101,105</sup> should convince any unbiased reader that there is ample evidence concerning the metabolic effects of fluorides in the body. There is this wealth of knowledge, not only of toxic concentrations, but of the theoretical and practical effects of low concentrations of fluoride, as advocated for the partial control of dental caries.

45. OBJECTION: Various bureaus endorse fluoridation but do not guarantee its safety.

APPRAISAL: The best guarantee of the safety of fluoridation lies in its observed results on people. The scientific literature covers numerous studies of the results observed and the conclusions achieved by highly competent scientists. There are studies of people who have drunk naturally-derived fluoridated water for generations<sup>33,94,106,107,108,109,110</sup> and there have been the more recent studies, several enduring for a period of 10 years, which compare results in cities with and without fluoridated drinking water.<sup>10,15,16,17,50</sup> Statistically-evaluated studies<sup>12,13,14,23</sup> have been published.

The best guarantee of the safety of water, fluoridated to optimal concentrations, lies in the people's good health and absence of systemic ill effects in places where it is being consumed. Testimony of physicians in Grand Rapids, Michigan, and Colorado Springs,

Colorado, states that "their patients do not experience more ailments, major or minor, than do the people of non-fluoride communities."<sup>36</sup>

Fluoridation of public supplies of water is endorsed and recommended by all of the major national organizations for human health. They include the American Dental Association, American Medical Association, American Public Health Association, National Research Council, Commission on Chronic Illness, U. S. Public Health Service, American Academy of Pediatrics, American Association for the Advancement of Science, American Water Works Association. At the local levels, fluoridation has the endorsements of such groups as the Health Departments of numerous cities throughout the country. Eighteen of the fifty largest cities now fluoridating their water include Chicago, Philadelphia, Baltimore, St. Louis, Washington, San Francisco, Pittsburgh, Cleveland, Milwaukee, and others.

There is no doubt that the competent scientific opinion in the United States is overwhelmingly in support of fluoridation. The concensus of those who have evaluated the measure exhaustively is that fluoridation is an effective, safe, practical and a much-needed public procedure for health.

46. OBJECTION: The grade of sodium fluoride used in the fluoridation of water contains arsenic.

APPRAISAL: Sodium fluoride usually is prepared from the mineral fluorspar, calcium fluoride, CaF<sub>2</sub>. When this mineral is treated with sulfuric acid, hydrofluoric acid, HF, is formed. This HF is neutralized with soda ash or sodium hydroxide to provide the sodium fluoride used in the treatment of water. Thus the fluorine ion used in water is identical with the fluorine combined in the mineral fluorspar as mined. Sodium fluoride so prepared is of uniform purity and can be added so that a uniform concentration results in supplemented water.<sup>37</sup>

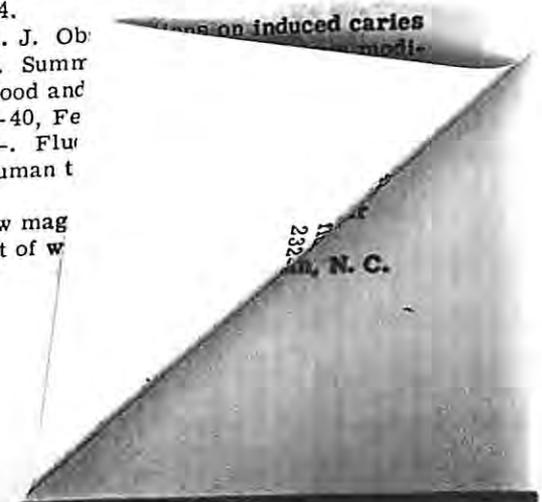
The average analysis of sodium fluoride has been shown to be as follows:<sup>37</sup>

<u>Fluoride</u>	<u>Per Cent</u>
Na F (sodium fluoride)	95.6
Na <sub>2</sub> SiF <sub>6</sub> (sodium silico fluoride)	2.0
Na <sub>2</sub> SO <sub>4</sub> (sodium sulfate)	2.0

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## II. INTERFERENCE WITH COMMERCIAL ACTIVITIES UTILIZING WATER

1. **OBJECTION:** Fluoridation adversely affects the manufacture of ice.

**APPRAISAL:** The only problem reported in industry to date was at Charlotte, North Carolina, where cracking of artificial ice was attributed to fluoridation. The local water supply was soft and had a low alkalinity. By using newer methods available to manufacturers of ice, the problem was entirely eliminated. Plants producing artificial ice in other cities have not experienced similar difficulty.<sup>1,2,3</sup>

2. **OBJECTION:** The Federal Food and Drug Administration might take action against processors of foods prepared with fluoridated water.

**APPRAISAL:** For many years fluoridated water has been used by the industries concerned with food, canning and beverages. Nearly 1500 communities in the United States now use fluoridated public supplies of water.<sup>4</sup> Nearly all of these communities engage in some forms of processing food or beverages, either commercial, in the homes of residents, or both. None have experienced harmful effects.

There is no risk of action by the Food and Drug Administration. The following statement appeared in the Federal Register of July 23, 1952:

"The Federal Security Agency will regard water supplies containing fluorine, within the limitations recommended by the Public Health Service, as not actionable under the Federal Food, Drug and Cosmetic Act. Similarly, commercially prepared foods within the jurisdiction of the Act, in which a fluoridated water supply has been used in the processing operation, will not be regarded as actionable under the Federal law because of the fluorine content of the water so used, unless the process involves a significant concentration of fluorine from the water. In the latter instance the facts with respect to the particular case will be controlling."

Such foods as corn syrup might contain several parts per million of fluorine as a result of a process using water containing 1.0 p.p.m. of fluorine. A few other rather common foods contain as high as 60 p.p.m. of fluorine naturally. Those items in a diet should cause no concern inasmuch as they do not result in excessive ingestion of fluorine since they are eaten in relatively small quantities as compared to the quantities of water consumed daily.<sup>2</sup>

3. **OBJECTION:** Fluoridation may interfere with the processing of food which requires fermentation by yeast.

**APPRAISAL:** Processors of foods and beverages have an understandable hesitancy to support changes in their supplies of water for fear that changes might have had effects on their products. Evidence now is available, from studies and experience within those industries located in areas where the water contains fluorides, which shows that there is no harmful effect from fluorides in concentrations recommended for dental health.<sup>5,6</sup>

The American Baking Institute, from a study conducted in 1950, reported: "The addition of fluoride ion in concentrations up to 10 parts per million in the sponge and dough water has no effect upon bread quality. Bakers in communities that plan to incorporate fluorine in the city water supplies as part of a program to reduce the incidence of dental caries should anticipate no difficulties in using such water for bread production."<sup>7,2</sup>

The American Dental Association<sup>2</sup> has reported that Green Bay and Kaukauna, Wisconsin, have some of the largest cheese plants in the world. Green Bay's water contains 2.5 p.p.m. of fluorine and Kaukauna's water has 1.8 p.p.m. of fluorine.

The St. Louis Medical Society<sup>8</sup> has reported that the breweries of Milwaukee used water from deep wells which contained as high as 1.8 p.p.m. of fluorine. The water has been in use since 1879. Then, in July 1953, fluoridation began in Milwaukee. According to the American Dental Association,<sup>2</sup> the following cities in Wisconsin have brewing industries and use water containing fluorides either in controlled amounts of about 1.0 p.p.m. or incidentally occurring at 2.0 and 3.0 p.p.m.: Rhinelander, Beaver Dam, Sheboygan, Columbus, Madison, Oshkosh, Green Bay, De Pere, and Allouez.

The Board of Health of New York City<sup>9</sup> has reported that the theoretical possibility was discussed that fluorides might affect the sensitive enzymatic systems in the fermentative processes. However, special industrial studies satisfied the brewers that no such action occurred when beer was processed using water with fluorine at a level of 1.0 p.p.m. After such conclusive evidence, Milwaukee and St. Louis started fluoridating their water.

4. **OBJECTION:** Fluorides in the water will ruin photographic film.

**APPRAISAL:** A careful search of the literature

on fluorides revealed no data or evidence of any kind to indicate that fluoridated water has caused or can cause adverse effects on photographic film.

Prior to fluoridation of the municipal water supply in St. Louis, Missouri, the Medical Society appointed a committee to investigate fluoridation. An exhaustive and objective evaluation of all phases was accomplished. The report<sup>8</sup> stated, without equivocation, that "The use of water containing the recommended concentration (1.0 p.p.m.) of fluorine has been shown to be without hazard in the industrial use of water."

The Board of Health of New York City reported<sup>6</sup> that it had conducted a survey of 35 municipalities of over 100,000 population using fluoridated water and an inquiry of 34 industrial associations and concerns. As a result of an evaluation of the literature the survey and the inquiry, the Board concluded that "water fluoridation presents no industrial problem of practical consequence."

It appears that the weight of evidence now available is in support of fluoridation as a process harmless to industry.

5. OBJECTION: Fluorides stain clothes in the laundry.

APPRAISAL: The evidence of the inability of water, fluoridated at the recommended level of 1.0 p.p.m., to stain clothes requires no specific scientific study to determine fact. The census of the American Dental Association<sup>4</sup> shows that 1492 American communities now are using fluoridated water. The population of 31,485,409 persons in these communities has had an opportunity to evaluate the staining of clothing during washing. Neither the housewives nor the laundries in these hundreds of cities have objected to fluoridation on the basis that the water stains clothes.<sup>6,8</sup>

6. OBJECTION: Fluoride in the water interferes with the growth of vegetables.

APPRAISAL: "Fluorine is one of the common, naturally occurring elements that constitute the physical basis for the earth's surface, including rocks, soil, water, the atmosphere, and living organisms."<sup>9</sup> The element, fluorine, occurs naturally in all river and well water, but in widely varying quantities.<sup>9</sup> Nichols<sup>10</sup> has pointed out that the concentration of fluorides in waters depends upon the availability and solubility of the minerals containing fluorides in or on the crust of the earth.

There is no evidence that 1.0 p.p.m. of fluoride will harm vegetables or other plants. Many communities, using waters naturally fluoridated at considerably higher levels, have been growing vegetables for generations. An Ohio producer of grass seeds<sup>11</sup> has reported that the company has used the city's fluoridated water to irrigate many of its test-lawns. The lawns have thrived for

years. In his discussion of experiences with fluoridation Pracy,<sup>12</sup> stated that fluoridated water is not harmful to lawns or flowers.

Representatives of the Department of Health, Education and Welfare<sup>13</sup> of the Federal Government, in a presentation before a Congressional committee, included a chart which indicates that many vegetables, as well as other foods, contain traces of fluorides. For example, cabbage has 0.31 - 0.50 p.p.m., lettuce 0.60 - 0.80 p.p.m., spinach 1.00 p.p.m., tomatoes 0.60 - 0.90 p.p.m., turnips 0.20 p.p.m., and carrots 0.20 p.p.m.

It seems reasonable to conclude that water which has been fluoridated, either by nature or by man, to a level of 1.0 p.p.m. will not harm growing plants or vegetables.

7. OBJECTION: Fluorides in the water interfere with electroplating.

APPRAISAL: McKee<sup>14</sup> has pointed out that sodium fluoride at 18° C. has a solubility of 42,200 p.p.m. Thus, it is inconceivable that water which contained only 1.0 p.p.m. of fluoride could be concentrated enough to produce any precipitation. It is of practical interest to note that the scientific literature does not reveal any recorded opposition to the fluoridation of communal drinking waters<sup>8</sup> by commercial electroplaters or industrial firms concerned with electroplating.

8. OBJECTION: Fluorides interfere with the manufacture of glass and plastics.

APPRAISAL: The St. Louis Medical Society<sup>8</sup> and the Board of Health of New York City<sup>8</sup> studied very thoroughly the industrial aspects of water-fluoridation. Their separate investigations of all available evidence brought each group to the conclusion that the use of water containing the recommended concentration of fluorine has been shown to be without hazards of any kind to industry.

The scientific literature does not reveal that there have been any data produced, or scientific evidence of any kind presented to support a belief that water fluoridated to a concentration of 1.0 p.p.m. has any deleterious effect in the manufacture of glass or plastics.

9. OBJECTION: Fluoridation of the water interferes with the production of syrups and malts.

APPRAISAL: An extensive search of the scientific literature does not reveal data or any evidence to support a belief that water fluoridated at 1.0 p.p.m. will interfere with the manufacture of syrups and malts.

There is testimony<sup>8</sup> by brewers, bakers and bottlers to the effect that water containing fluorides at a concentration of 1.0 p.p.m. is without hazard to their industries. In an official report of an evaluatory study, the Board of Health of New

York City<sup>6</sup> noted that the research-chemists of various industrial groups, including brewers, bakers, bottlers and canners, had conducted several studies. The special concern of brewers was based on the theoretical possibility that fluoride might affect the sensitive enzymatic systems participating in the processes of fermentation. The specific studies established that no adverse effects occurred. Milwaukee and St. Louis started to fluoridate their communal waters after this conclusive evidence was published.<sup>8</sup>

10. **OBJECTION:** People will not buy prepared foods, if fluoridated water is used in their production.

**APPRAISAL:** A search of the literature does not reveal any evidence to indicate that the 31,485,000 persons now drinking fluoridated water in 1492 American communities<sup>4</sup> had changed either their preferences or their habits of buying as a result of the use of fluoridated water in the processing of foods.

The experiments of Cox and Nathan<sup>15</sup> demonstrate that fluoride is entirely tasteless at the level of 1.8 p.p.m. or below, and that even at 10 p.p.m. the untrained person would still be unable to detect a taste.

Manufacturers of food products have not published data to indicate that their use of fluoridated water has affected adversely either the quality or sales of their products.<sup>8</sup>

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### III. EXPENSE

1. **OBJECTION:** Fluoridation is a great waste because only a small proportion of the water goes for human consumption.

**APPRAISAL:** It is true that communal waters treated with chlorine and softening chemicals, as well as with fluorides, are used for purposes other than drinking. Nevertheless, it has been found more practical to have the entire water system treated than to attempt to treat the drinking water separately. For fluoridation, the range of costs has been reported to be from two to 32 cents per person per year; the average cost reported by the American Dental Association<sup>1</sup> is about nine cents annually per person. Bull<sup>2</sup> and others have reported that the cost varies with the characteristics of the city and the chemicals used.

Fluoridation of the public supply of water is not waste. It is the most effective established method of reducing dental caries on a practical basis, according to the American Dental Association.<sup>3</sup>

2. **OBJECTION:** Costs are increasing all of the time, and the city cannot afford to add another item to the budget.

**APPRAISAL:** The statement that costs are increasing all of the time is true. However, the savings from fluoridation by its proven ability to reduce dental caries are so great, and the cost of fluoridation is so small, that a community truly cannot afford to waste money by using water deficient in its content of fluoride.<sup>4</sup> Numerous studies have demonstrated the benefits of controlled fluoridation.<sup>5,6,7,8</sup> It would seem that no city could afford to lose these benefits since the costs are quite insignificant.

3. **OBJECTION:** Fluoridation of the supply of water is more expensive than other methods of administration which are equally effective.

**APPRAISAL:** The National Research Council<sup>9</sup> has stressed that water is the only vehicle for fluoridation which can be appraised on the basis of prolonged epidemiological observations as well as clinical applications. The Food and Nutrition Board of the Council<sup>9</sup> considered the possibilities of using both solids and liquids as vehicles for fluoride. Sognaes<sup>10,9</sup> states that "water is the most reliable vehicle for fluoride supplements."

It may be concluded, therefore, that there is no evidence or studies to support a statement that there are other methods of administration equally effective in reducing caries in man.<sup>11</sup>

Fluoridation of water is not only the best established vehicle but the evidence indicates that it

also is the most effective, inexpensive and convenient. Kesel<sup>12</sup> has concluded that "any means for caries control that requires conscientious cooperation on the part of the individual, that denies him something which he enjoys, or requires him to perform a ritual that is inconvenient, cannot be very effective in controlling caries in large numbers of people."

Pearlman<sup>13</sup> concluded his evaluation of vehicles for fluoridation by stating, "In consideration of the low cost of chemicals and the limited technical attention required for continued operation, fluoridation of the water supply is actually the least expensive and most convenient method known for caries control."

4. **OBJECTION:** "Drug" grade fluoride is too scarce and expensive for use in the public water, so the commercial grade plainly marked "for industrial use only" is used.

**APPRAISAL:** There appears to be an assumption by those making this assertion that the commercial grade of sodium fluoride is in some way dangerous, ineffective or perhaps injurious to the health of the people who drink the water. This assumption is refuted directly by the American Water Works Association's Tentative Standard Specifications for Sodium Fluoride<sup>14</sup> which reads, "The sodium fluoride supplied under these specifications shall contain no soluble mineral or organic substances in quantities capable of producing deleterious or injurious effects upon the health of those consuming the water which has been treated properly with sodium fluoride."

5. **OBJECTION:** The equipment utilized to fluoridate water is very expensive.

**APPRAISAL:** Water can be fluoridated at a cost per capita which will not be a financial burden to anyone. For example, Muegge<sup>15</sup> has shown that equipment for feeding can be installed for only \$500 to \$1250 to supply the water needed in systems ranging from small to those which pump over 2 million gallons daily. Larger water systems, such as those pumping 1.25 million gallons per day, may use gravimetric feeders whose costs of installation range upward from \$1500. The use of the various types of fluorides requires certain volumetric or gravimetric feeders. Costs are in the price ranges stated for sodium fluoride.<sup>15</sup>

The Board of Health of New York City submitted an official study<sup>16</sup> to the Mayor which stated that the total annual cost of fluoridation of water for New York City, including the annual amortized cost of treatment and operation by private utilities, would -

be only about eight to 15 cents per capita. Even with some upward adjustment for contingencies, fluoridation for all people served by the public supply of water in the City would be nine cents per capita or less.

The initial cost of equipment to fluoridate is small and would not be noticed in a community's budget. The life of the equipment can be amortized over a period of 10 to 20 years and reduce the annual cost to an insignificant figure. The cost of an average filling will pay for fluoride for one person for about 30 years.

Experience in hundreds of communities shows conclusively that fluoridation is an inexpensive procedure.<sup>1</sup> The usual range in cost is from several hundred dollars for small towns to about 15,000 dollars for a city of 2,500,000 persons.<sup>17</sup>

6. **OBJECTION:** Additional personnel who are highly trained must be employed to operate the equipment for fluoridation.

**APPRAISAL:** The personnel of water works have demonstrated in hundreds of American communities that the addition of fluorides to a municipal supply of water is practical from the standpoint of engineering.<sup>1</sup> The methods for fluoridating water are no more difficult than other procedures in treating water; moreover, the machinery and equipment, commonly used in water plants, are easily adapted to fluoridation.<sup>18,2</sup> Personnel in water plants find the equipment for feeding fluoride accurate and reliable and the usual well-trained attendant at the water plant is efficient in accomplishing the simple procedures required.<sup>1</sup> Tests for fluorides have been refined and simplified so that fluoridation can be controlled accurately, even by part-time water superintendents in small towns.<sup>19</sup>

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#### IV. PROBLEMS OF CONTROL OF ENGINEERING

1. **OBJECTION:** The technics for measuring the concentration of fluoride in water are very difficult and inaccurate.

**APPRAISAL:** The American Public Health Association, American Water Works Association, and the Federation of Sewage and Industrial Waste Associations have recommended the use of the successful colorimetric procedure for measuring the concentration of fluorides in water.<sup>1,2,3,4</sup> The procedure recommended by these organizations is simple. A mixture of a measured sample of water and a testing solution of zirconium-alizarin reagent is compared to a standard, such as the Taylor Comparator. This Comparator is designed so that the usual operator in a water works can make the determination of concentration of fluoride with acceptable accuracy.<sup>5</sup> Kramer, Kroner and Ballinger<sup>6</sup> also have reported that accurate measurements can be made readily by inexperienced persons.

Engineers and chemists in water works agree that colorimetric methods of analysis of fluoride in water are simple and rapid and that these procedures can be accomplished by the regular operator.<sup>7,8,9,10</sup>

2. **OBJECTION:** There is a lack of means of dealing with the objections and questions of the public.

**APPRAISAL:** Fluoridation is a public-health measure and all authorities, including operating managements of water-supplies, agree that final responsibility lies with the state department of health. This responsibility, however, may be delegated to the local health officer.<sup>6,7,11,12,13,14,15,16</sup>

Although personnel in the water-works are essential to the operation of fluoridation as a process, fluoridation is initiated by the state health officer and the director of dental public health with the cooperation of the medical and dental societies. Civic groups and individuals are brought into the planning and approval must be obtained from the legislative body.<sup>11,17</sup>

Since broad responsibility for matters of health lies with the departments of health, it is apparent that questions and objections relating to health-measures including those concerned with fluoridation, should be decided by the department of health. Hilleboe<sup>17</sup> has reported that questions and complaints in the early days of the fluoridation of water during the study of Newburgh and Kingston, New York, were handled by the health-officer. Complaints were answered in the local newspaper by editorials.

Information on fluoridation is available upon

request from the American Dental Association and the various departments of health operating at the level of the local community or the state.

3. **OBJECTION:** Repair and replacement of equipment for fluoridation will be a constant problem because of the corroding action of fluorides and the formation of incrustants.

**APPRAISAL:** Fluorides are corrosive and tend to produce incrustation only in very high concentrations. No problem arises from the water supplied for drinking which contains fluorine at a concentration of 1.0 p.p.m. W. L. Harris,<sup>18</sup> Superintendent of the Water Department, Grand Rapids, Michigan, testified before a Congressional Committee that, over a period of 10 years of fluoridation, at 1.0 p.p.m., there had been no damage or corrosive condition observed by any tests that could be made. Harris stated also that he did not expect to find any damage.

Problems of corrosion and incrustation have been reported within the feeding lines at water works by Muegge<sup>19</sup> and Maier.<sup>15</sup> These problems occasionally occurred in lines conveying high concentrations of fluorides. However, Muegge<sup>19</sup> has suggested that flexible plastic pipe feeding lines will resolve the condition. Maier<sup>15,16</sup> has reported that the problem of corrosion, such as occurs with the use of hydrofluoric acid, is overcome easily by using feeding pipes of monel metal or hard rubber. Maier also points out that any incrustation which may develop as a result of using fluorides may be removed easily by the operators in water works. No repair or replacement of equipment is required.

4. **OBJECTION:** Adding fluoride to water is a big nuisance to the personnel of water works.

**APPRAISAL:** The mechanics of fluoridation are no more complicated than those of purification of water. Moreover, the machinery and equipment commonly used in water plants is easily adapted to the addition of fluorides. Adaptation of equipment and application of necessary safeguards to prevent accidental overdosage are the two major elements in this new program for the public's health.<sup>19,20</sup>

Personnel operating water works realize fully that the simple principles and devices used in the addition of fluorides to water, the safe procedures used in fluoridation, and the small amounts of time necessary for the maintenance of equipment constitute an essential contribution to the health of the community. Knowledge of the benefits, provided for the people served, ensure that

conscientious personnel in the water works will not consider fluoridation a nuisance.

Hilleboe,<sup>21</sup> at the conclusion of the 10-year study of fluoridation in Newburgh and Kingston, praised the personnel of water works by stating "The staff at the water treatment plant in Newburgh deserves special mention for its wholehearted cooperation in the fluoridation project."

Harris<sup>18</sup> reflected the general attitude of devoted public service in his remarks before a Congressional Committee concerning operations of a water works which regulates fluoridation at Grand Rapids, Michigan. Other superintendents, engineers and operating personnel of water treatment plants likewise reflect the general attitude of conscientious service of the personnel at water works by means of articles in the scientific literature. The references in the literature clearly indicate that fluoridation is a measure fully endorsed by water works personnel. There is no evidence whatsoever to support an assertion that adding fluorides to water is considered anything but a worthwhile service by personnel in plants providing treatment of water plants.

5. OBJECTION: A technical problem develops because fluorides combine with so many other compounds in the water.

APPRAISAL: Muegge<sup>19</sup> has reported that, in the use of undersaturated solutions of sodium fluoride, precipitates and inert solids are caused by a solution in which the hardness of the water is too great. He recommends the use of a soft water to reduce precipitation. The formation of slightly soluble compounds, upon addition of sodium fluoride to water, is handled by softening the water, and the addition of superphosphates. In dilutions of hydrofluosilicic acid some difficulty has occurred because of the formation of a precipitate or a jelling action due to reaction with hard water. Muegge reports that water with a hardness of less than 50 p.p.m. can be used for dilutions of hydrofluoric acid.

Maier<sup>16</sup> has reported that consideration is given to processes of treatment of water which might remove fluorides. These processes are lime-softening in the presence of magnesium, coagulation by alum or sodium aluminate feeding of bentonitic clays, and treatment by activated carbon at low values of pH. It is advisable to add fluorides after these treatments have been completed. Maier also has concluded that "There are no known reactions between fluorides at 1.0 p.p.m. in water and compounds formed in water after chlorination."

The evidence discussed makes it apparent that there is no problem whatsoever in the daily consumption of water fluoridated at 1.0 p.p.m.

6. OBJECTION: Different concentrations of fluorides must be maintained by engineering personnel

in different regions of the country and in different seasons of the year.

APPRAISAL: Galagan and Lamson<sup>22,23</sup> have reported that concentrations of fluorides should be adjusted to climatic conditions. They have concluded that 1.0 to 1.2 p.p.m. of fluorine may be considered optimum in zones comparable to the area around the Great Lakes, whereas 0.6 p.p.m. may be considered equally effective in areas similar to southern Arizona. They have suggested that mean annual temperature is the most practical measure of climatic conditions available at the present time. Maier<sup>16</sup> has reported that relative humidity is also an important factor to be weighed, together with the annual mean temperature. His data led Maier to the conclusion that a mean annual temperature of more than 55 to 60° F. would indicate that water containing less than 1.0 p.p.m. of fluorine should be used.

When the optimum concentration is established by scientific reasoning and calculation as suggested by Galagan, Lamson and Maier, the device for feeding a proper amount of fluorides into the water can be adjusted easily. Such engineers as Zufelt, Smith and Williams<sup>24,25</sup> all agree on this conclusion.

7. OBJECTION: Multiple sources of water make an impossible situation for the addition of fluoride to a communal supply of water.

APPRAISAL: The problem of adding fluorides to multiple sources of water is one which requires careful consideration by skilled personnel. Bull, Hardgrove, and Frisch,<sup>5</sup> in evaluating this type of problem, have stated that "Communities having several wells that are pumped into the water main at different locations will use an installation for each well. However, should more installations be needed, for a large community, the expense of the extra equipment is not an important factor since the per capita cost is small and skilled personnel, experienced in the feeding of chemicals into a water system, are available.

Difficult situations are not necessarily impossible to resolve. For example, Madison, Wisconsin, had nine different sources of water. The problem was solved by the determination and ingenuity of the engineers of its water works.<sup>8</sup>

8. OBJECTION: When fluoride has been added to the supply of water, many phases of treatment cannot be carried out.

APPRAISAL: The American Water Works Association endorses the addition of fluorides to municipal supplies of water and has declared addition feasible from the engineering standpoint.<sup>26,27</sup> Muegge<sup>19</sup> has stated that "fluoride-bearing chemicals can be applied to communal water supplies within the optimum range for dental caries control

without jeopardy to the consumers of water works personnel." Scientific authorities agree that fluoridation is a feasible and practical procedure of engineering.<sup>26</sup>

Maier<sup>15,16</sup> has reported that the processes which have a tendency to remove fluorides include (1) lime-softening in the presence of magnesium, (2) coagulation by alum or sodium aluminate, (3) feeding of bentonite clays and (4) treatment with activated carbon at a low pH. Maier advises that fluorides be added *after* these steps of treatment. Here, then, is a simple and obvious solution for the water plant.

According to the American Dental Association,<sup>28</sup> over 31 million persons are drinking fluoridated water. No evidence has been produced to substantiate an assertion that the treatment of water is being hampered or prevented in any way. To the contrary, all reports on fluoridation have been entirely favorable. The assertion, therefore, is no more than a mere conjecture, unsupported by facts.

9. OBJECTION: Fluorides are precipitated out of a solution by water-softening chemicals.

APPRAISAL: Muegge<sup>19</sup> has reported that water used to make solutions of sodium fluoride for feeding operations should be of low hardness or should be softened to avoid precipitation. Maier<sup>15,16</sup> supports this opinion and has shown that water-softening chemicals are used in water plants to reduce the loss of fluorides by precipitation.

The investigations by Williams<sup>29</sup> led him to conclude that no detectable loss of fluoride occurred when fluoridated water is passed through household softener. Maier,<sup>16</sup> also reporting on home softeners, has stated that "the salt regeneration system will not remove the added fluorides."

10. OBJECTION: It is difficult to control the concentration of fluoride throughout the distributory system for water so that the proper dosage reaches the consumer.

APPRAISAL: Harris,<sup>18</sup> Superintendent of the Water Department, of Grand Rapids, directed the engineering phases of fluoridation in that City for more than 10 years. He testified before a Congressional Committee that the increase in concentration of fluoride in the water-supply system was checked very closely after fluoridation was started in January, 1945. It took 10 days to pass the fluoridated water throughout the more than 400 miles of the system. Nevertheless, Harris stated, "from that time on we have always been able to find the amount of fluoride at the end of the main essentially the same as that which we added. There was no build-up at any place."

Zufelt,<sup>8</sup> Superintendent of the Board of Water Commissioners at Sheboygan, Wisconsin stated,

"Laboratory control of fluoridation involves one determination of fluoride in the filter effluent before the addition of fluoride, and five tap water samples each day. Three of the latter are taken at the laboratory tap at eight-hour intervals, one at the chemist's home and one at a different sampling point in the distribution system each day. Results are quite uniform . . ."

These reports of practical operation and experience show, when the addition of fluorides to drinking water at the desired concentration is accomplished at the water treatment plant, that the same level of fluoride is distributed and maintained uniformly throughout the water-system. Euler<sup>30</sup> has corroborated these findings and shown that the consumer does obtain the proper amount of fluoride at the water taps anywhere in the distributing system.

11. OBJECTION: Fluoridation of water will cause bursting of the water-mains.

APPRAISAL: Bursting of water mains would have to be produced by pressures. Sears<sup>31</sup> has stated that "when a solid, liquid, or gas is subjected to external forces, then in general, a force is exerted against every element of the area within or bounding the substance adjacent to that area."

Gannon<sup>32</sup> has written that the composition of water does not affect its energy and that its pressure is an indication of the amount of energy expended.

Pressure at the water works is necessary so that the water in the distributory system reaches the consumer at a desired rate of flow. High pressures are forced into the system for supplying water when, for example, a heavy demand for water is created by prolonged fire fighting. It is at such times that high pressures may cause corroded or defective water-mains to burst.

No evidence has been presented in the scientific literature to indicate that fluorides ever caused a water main to burst.

12. OBJECTION: Fluoridation poisons municipal waters where it is not wanted, when fluoridated water is used to discharge sewage at points farther upstream.

APPRAISAL: Maier<sup>16</sup> has reported that the content of fluoride in sewage almost immediately reaches the same concentration as in the supply of water. He stated, also, that this situation has no effect on any process in the treatment of sewage. Gannon<sup>32</sup> has stated that traces, concentrated at 1.0 p.p.m. of fluorine, are decreased further by the dilution factor of the stream as concentration is inversely proportional to the flow of the stream. Therefore, the concentration decreases as the flow of the stream increases.

Water plants using water contaminated with sewage must treat completely the water taken .

from the stream.<sup>33</sup> Present measures of treatment include the measurement of fluorine.

The evidence indicates clearly that fluorides present in sewage as a result of the disposal of sewage upstream could not produce poisoning of municipal waters. Indeed, if fluorides could be retained at the proper concentration of about 1.0 p.p.m., there is evidence to indicate that the proved benefits of fluorides could be provided for a city entirely free of charge.

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## V. DISPLACING BETTER METHODS FOR ADMINISTERING FLUORIDE

1. **OBJECTION:** Despite claims to the contrary, calcium fluoride is sufficiently soluble for use in fluoridation of communal water supplies and should be used in preference to the far more poisonous sodium fluoride.

**APPRAISAL:** Maier,<sup>1</sup> in 1950, noted that calcium fluoride is the cheapest source of fluoride but indicated, because of its insolubility, that it would be difficult to feed. He predicted that the calcium salt might become the preferred fluoride in some of the larger plants, where it could be fed directly into the water. Nichols<sup>2</sup> stated, also, that fluorspar, 70 per cent calcium fluoride as mined domestically, probably could be adapted to the fluoridation of water.

Maier and Bellack,<sup>3</sup> both scientists of the U. S. Public Health Service, recently have overcome the problem of low solubility of calcium fluoride. Maier<sup>3</sup> has described the device which will permit the use of fluorspar in water plants. According to Maier<sup>4</sup> the "fluorspar dissolver utilizes solutions of an aluminum salt for dissolving fluorspar in a modification of a sludge-blanket type of softening apparatus. By controlling the rate of feed of aluminum solution, selecting the proper surface area, and utilizing a prescribed mixing system, a saturated solution of fluorides can be obtained along with a fixed aluminum-salt concentration." Thus Maier made his own prediction come true with this new device. Costs of fluoridation can be reduced to as low as three cents per person per year if fluorspar is used.

Although calcium fluoride, or fluorspar, in many places may displace sodium fluoride, it will do so on the basis of economy, not on the basis of danger of poisoning, as charged in the objection. Nichols<sup>2</sup> has stated that fluorides in dilute solutions in drinking water ionize to form fluoride ions. These ions are identical regardless of the compound used as a source. The ions are identical in every respect with those found in natural waters since the fluorides used are obtained from deposits of mineral. It is a well-established fact that fluoride ions in traces of 1.0 p.p.m. are completely nontoxic in drinking water.

2. **OBJECTION:** The topical application of fluoride to the teeth is equally as efficient in reducing the incidence of dental caries as the consumption of fluorides in the drinking water, and presents fewer problems.

**APPRAISAL:** The topical application of fluoride has been shown by Knutson and Scholz<sup>5</sup> to produce an average reduction of 40 per cent in the incidence of dental caries. The studies of controlled fluoridation of supplies of communal water have demonstrated a 58 per cent reduction in the incidence of dental caries in permanent teeth in Newburgh, New York,<sup>6</sup> an 80 per cent reduction in caries experience in the six-year-group in Evanston, Illinois<sup>7</sup> and 53.9 per cent in the age-groups 5 to 15 in Brantford, Ontario.<sup>8</sup>

Topical applications have been evaluated by the St. Louis Medical Society<sup>9</sup> which reported the following conclusions: "Topical application of fluorides (directly to the teeth) has proven to be of definite value as a measure of individual prophylaxis against tooth decay. It has been demonstrated, however, to be less effective in its reduction than that produced by the systemic intake of fluoridated water from birth. The limited number of dental personnel available in both public-health and private practice, and the expense of such a method, make it a poor choice of methods of treatment in comparison with fluoridation of a community's supply of water. It is wholly impractical as a public-health measure, therefore, in any but the small or rural areas.

Aside from the facts just established, fluoride must be applied topically in several series of treatments. Conscientious cooperation, personal inconvenience and loss of time, as well as a budget are required. Kesel<sup>10</sup> has concluded, in view of these factors, that the topical application of fluoride cannot be very effective in controlling dental caries for large numbers of people.

3. **OBJECTION:** Individuals may receive the full benefit of fluorides by using toothpaste or mouthwashes containing any one of several of these compounds.

**APPRAISAL:** Hillenbrand,<sup>11</sup> speaking formally for the American Dental Association, stated that "the evidence accumulated in the past 20 years to support community fluoridation is overwhelming in comparison to the amount of clinical evidence to support the usefulness of fluoride dentifrices. It would be a disservice to the dental health of the public if the promotion of fluoride dentifrices should lead to the misconception that their use is an adequate substitute for the controlled fluoridation of municipal water supplies."

Sognaes<sup>12</sup> has observed that there is a lack of specific knowledge, *except about fluoridation of water*, with regard to the effect of fluoride supplements on caries in man. The Council on Dental Therapeutics<sup>12</sup> of the American Dental Association has stated that "all available evidence, therefore, indicates that fluoridation is the method of choice in providing the dental benefits of fluoride."

No studies have been reported which would provide valid support for the objection. Until scientific evidence has been developed and tested such claims must be considered to be merely interesting conjectures.

4. **OBJECTION:** Fluorides in tablets present a more effective and less expensive method for administration to human beings than any other form of these chemicals.

**APPRAISAL:** The daily consumption of tablets raises questions of effectiveness and practicality. Trained personnel at the water plant can ensure precisely controlled levels of fluorine. But experience with various home remedies — even with the aspirin tablet — prompts caution. The philosophy that "one tablet is good, two are better," may produce harm. A child's accidental ingestion of a large number of tablets is a great hazard since such mistakes are a common occurrence in home-accidents.<sup>14</sup> The Board of Health of New York City has concluded that the use of tablets as a vehicle for fluorides has an unknown effectiveness, is difficult to regulate, is inconvenient, and is an accident-hazard. Approximate cost annually per person would be about \$3.65, as a minimum, compared to an estimated maximum of nine cents per capita for fluoridation of water.<sup>14</sup> The St. Louis Medical Society,<sup>9</sup> in its extensive evaluation of the merits of various vehicles for fluoridation, concluded that "the expense and distribution problems involved in the dispensing of tablets make tablets an impracticable choice..."

The National Research Council<sup>15</sup> has stated that, except for water as a vehicle of fluoridation, no supplement or alternative measure "could immediately be put to use on the strength of present evidence in regard to the amount of fluoride ingested and caries-preventive effect in man." The Council has concluded that the adjustment of the content of fluoride of drinking water is in principle and in practice the soundest and most effective approach known today for the prevention of caries on a large scale.

5. **OBJECTION:** Drinking water is not a suitable vehicle for administering fluorides.

**APPRAISAL:** The St. Louis Division of Health,<sup>16</sup> in recommending the fluoridation of the municipal supply of water stated that "no other public-health procedure has had so many years of scientific study and evaluation before its introduction and

recommendation to the public as fluoridation of communal water supplies."

The National Research Council,<sup>12</sup> through its subcommittee on optimum levels of fluoride, considered specifically the matter of the most suitable vehicle for fluoridation. The vehicle must provide a safe and effective means of reaching the population most concerned, namely, children, from infancy to adolescence. Also, its consumption must tend to be self-limiting; in other words, the capacity of a child of a given age to consume the vehicle should not exceed the limit of a safe intake of fluoride. At the same time, the nutritive value, the usage, and the cost of the vehicle should be advantageous to the largest part of the population. Finally, the vehicle should be such that there would be uniformity of response and ease of regulatory control. Fluoridation of communal supplies of water meets all of these specifications, according to the National Research Council's report.<sup>12</sup>

Drinking water is the only vehicle for which a considerable body of epidemiological and clinical information exists. The effectiveness and safety of consuming fluoridated water is well-established.<sup>14</sup>

Sognaes<sup>12</sup> summated the matter concisely in discussing the evaluation of the National Research Council. He said: "... we arrived at the conclusion that available evidence indicated that the effectiveness and safety of fluoride administered in the drinking water, at the recommended level, was better established than any other means of fluoride administration in the prevention of tooth decay."

6. **OBJECTION:** Fluorides, prepared in solution by the druggist, may be added to one's own drinking water. This method of administering fluorides is better than fluoridation of the communal water and permits the use of drug-grade fluorides.

**APPRAISAL:** The various proposals for administering fluoride must be evaluated on the basis of their ability to meet definite requirements. The qualifications of a suitable vehicle for fluorides include: (1) safety, (2) effectiveness in reaching children from infancy to adolescence, (3) self-limitation of its consumption, or the capacity for the child of a given age to consume the vehicle should not exceed the limit of a safe intake of fluoride, (4) the nutritive value usage and cost of the vehicle chosen should be advantageous to the largest part of the population, and (5) the vehicle selected should permit uniformity of response and ease of regulatory control.<sup>12,15</sup>

Communal supplies of water, according to the National Research Council,<sup>12</sup> meet all of these qualifications. It must be remembered that communal water is the only vehicle for fluoridation which can be judged on the basis of prolonged epidemiologic observations as well as clinical application.<sup>15,12</sup>

Fluorides prepared in solution by the druggist do not meet several of the qualifications declared

essential by the National Research Council.<sup>15</sup> Properly prepared by a druggist the solution of fluoridated water would no doubt be just as effective and safe as the communal supply.<sup>14</sup> On qualification (3) the two methods should be about the same. With regard to the qualifications (4) and (5), the druggist's solution has certain disadvantages. The costs of preparing, bottling and distributing such water has been estimated to be no less than \$1.00 per week per family, or more than \$50.00 annually. This enormous cost should be compared with about 40 cents per year per family for fluoridating the communal supply.<sup>14</sup> Convenience and practicality also enter into comparisons. For example, are children who most need the fluorides likely to go to the trouble of consuming the alternative vehicle at home and at school with the regularity they would in using communal waters? Would the bottled solution be used as freely by children as tap water?<sup>14</sup> Would not the use of all cooking and drinking water from a bottle rather than from a convenient faucet be considered impractical by a high proportion of children and housewives?<sup>14</sup>

There is no advantage in using drug-grade fluoride because the grade of fluoride used in the fluoridation of communal water contains no soluble substance that would be deleterious or harmful to those persons using this water.<sup>17</sup>

7. OBJECTION: One could just as well add fluorides to salt, milk, bread or other foodstuffs.

APPRAISAL: Sognaes<sup>12</sup> stated that "if fluoride is added to table salt in amounts sufficient to provide an additional 1 mg. of fluoride daily, the following calculations are pertinent. Two mg. of NaF contain 1 mg. of F; assuming a daily intake of 10 g. of NaCl, the salt would need to contain 0.02 per cent NaF. To obtain 2,500 mg. of F., possibly a fatal dose, it would be necessary to ingest 2500 x 10 g. of salt, or 25 kg.; this is clearly impossible. Fatal poisoning is out of the question."

Pearlman<sup>18</sup> has reported that there is no factual evidence to support an assumption that the use of fluoridated milk will result necessarily in a reduction of dental caries. Only experiment and investigation may reveal whether or not fluoridated milk offers such benefits. Until the accumulation of scientific data indicates the usefulness of other procedures the fluoridation of communal supplies of water offers the only established means of reducing the incidence of dental caries on a popular basis.<sup>18,19</sup>

An extensive study and evaluation of fluoridation led the St. Louis Medical Society<sup>9</sup> to certain conclusions about the merits of various vehicles for fluorides. The Society stated that "alternatives (to fluoridated water) suffer from either the risk inherent in dispensing necessarily concentrated stock solutions, or the uncertainty of dosage through break, milk, salt, or other foodstuffs whose

intake by the individual varies more widely than does the total intake of water, including the water in solid food."

The National Research Council's Food and Nutrition Board<sup>20,15</sup> arrived at a definite conclusion that the available evidence indicated that the effectiveness and safety of fluoride administered in the drinking water, at the recommended level, was better established than any other means of administering fluoride in the prevention of dental decay.

8. OBJECTION: Bottled water provides a better method of administering fluorides.

APPRAISAL: Drinking water is the only vehicle for fluoridation which can be judged on the basis of prolonged epidemiological observations as well as clinical application.<sup>15</sup> The National Research Council has stated, because of the knowledge already available concerning drinking water as a vehicle, that "bottled fluoridated water is the only source meriting serious consideration as a fluoride supplement whereby fluoridation could immediately reach communities without a communal water supply." However, the Council points out that "this vehicle, while the most nearly ideal, as such, might be too costly as a source of water in view of the expense of bottling, distributing and ensuring compliance with sanitary regulations."

The Board of Health of New York City,<sup>14</sup> in an official evaluation of considerations of fluoridation for the mayor, discussed the element of cost of bottled water. The Board stated that the use of bottled fluoridated water for a family of four persons would cost in excess of \$50 per year as compared to about 40 cents per year for fluoridated communal water. A further important disadvantage of bottled water would be that of inconvenience when compared with the ease of using water from a faucet.

The use of bottled water is not a suitable substitute where fluoridation of communal water supplies is possible. It lacks convenience, adds to the cost for the same benefits, and requires conscientious effort of the family to obtain and to use with the same freedom and regularity as fluoridated communal supplies of water.<sup>21,10,12,22</sup>

9. OBJECTION: The consumption of fluorides can be brought to an optimum level by an increase in the diet of foods containing natural fluorides.

APPRAISAL: The National Research Council<sup>15</sup> concluded from its study of providing an optimum amount of fluoride in the diet that (1) the American diet normally provides *less* than the optimal concentration for preventing caries, (2) vehicles, liquid or solid, other than fluoridated communal water supply, cannot be recommended at present, (3) in order to determine the value of other dietary vehicles of fluoride, additional studies are recommended of consumption of food and water from

infancy to adolescence and on the metabolism of food-borne versus water-borne fluoride, and (4) if any vehicle, upon further study, should prove to be promising, it is imperative that such a vehicle be subjected to clinical studies adequately controlled in human beings before any large-scale application is made. The Council also has stated its conclusion that "on the basis of epidemiologic and experimental observations in fluoridated communities, the most reliable vehicle for supplementing the fluoride intake is water."

The studies of McClure,<sup>23,24</sup> Armstrong and Knowlton,<sup>25</sup> and others<sup>26</sup> indicate clearly that common foods have a generally low content of fluoride. For example, McClure's studies<sup>23,24</sup> of over 130 foods show that vegetables, meats, cereals and fruits, found in the average diet, contain from 0.2 to 0.3 p.p.m. as consumed. Tea and seafood are two notable exceptions to the generally low content of fluoride.<sup>12</sup> However, a cup of tea contains only 0.12 mg. of fluorine and it would take about 10 cups of tea to equal the fluoride received from a quart of drinking water containing 1.0 p.p.m. Sognaes<sup>12</sup> also has reported that seafood contains 5.0 to 15 p.p.m. of fluorine, as consumed. The average consumption of fish (13 g.) in the United States is only about one-tenth of the average in Japan (100 g.). The latter figure provides only 0.5 mg. of fluorine daily per individual. Americans, in childhood, are not heavy consumers of tea and it appears highly unlikely that they could, or would, change their diets enough to obtain their fluorides entirely from food. Fluoridated drinking water clearly is the method of choice.<sup>14,15,12,16,18,20</sup>

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## VI. INTERFERENCE WITH HUMAN RIGHTS

### 1. OBJECTION: Fluoridation is mass medicine.

**APPRAISAL:** Dean<sup>1</sup> has answered this objection directly by stating "any assumption that fluoridation is mass medication reveals a lack of knowledge of the carious process and its associated pathology. Medication implies the application of a medicinal substance or agent for the treatment or cure of a disease — the application of remedies. Fluoridation is not a treatment or cure for dental caries. Dental caries produces a nonhealing lesion; dental enamel once injured never repairs itself, with or without medication. Fluorine simply prevents the decay from developing. In short, fluoridation of public water supplies simulates a purely natural phenomenon — a prophylaxis which nature has clearly outlined in those communities that are fortunate enough to have about 1.0 p.p.m. of fluorine naturally present in the public supply of water, such as, Denver, Colorado, Aurora, Illinois, and many others."

Black<sup>2</sup> has published similar views and points out that 1401 public water supplies serving 4,188,000 consumers in the United States contain more than 0.7 of fluoride. He concludes, as did Dean, that fluoridation consists of "merely a process of supplementation, that is, adjusting a normal constituent of most natural waters to its optimum content from the standpoint of the public's health. Obviously, fluoridation is not medication, either mass or individual. Fluorides in minute quantities are a normal constituent of the human body."<sup>3</sup>

### 2. OBJECTION: Fluoridation is unconstitutional since it interferes with freedom of religion.

**APPRAISAL:** The assertion that fluoridation violates the constitution and that it interferes with religious freedom has been evaluated in a number of courts. The first five decisions of courts on fluoridation were rendered in 1952. These decisions concerned Northampton, Mass., San Diego, Calif., Chehalis, Wash., Baltimore, Md., and Fargo, N. D. In all instances

fluoridation was upheld by the court, and in all except the case tried in Northampton the main issue was the contention that fluoridation violates the Fourteenth Amendment to the Federal Constitution, which indirectly protects persons from an invasion of their religious freedom by action of state or local governments.<sup>2</sup> Land and Mosen-thal<sup>4</sup> have presented the details of these five cases in a special article. The findings were similar in the five cases; each decision reiterated the philosophy that no constitutional rights of citizens to freedom of religious belief would be invaded or violated by the adoption of fluoridation. In Baltimore<sup>2</sup> it was ruled that "a person has a right to believe in any particular religion or faith that he desires, but he does not have the freedom to act in accordance with the tenets of any of those religions, since in his action he is bound to follow the laws duly enacted for the preservation of the health of citizens generally. He cannot object on religious grounds to laws enacted, either by the nation's, state's or city's authorities. I find in this case that from the evidence none of the constitutional rights of the plaintiff to freedom of religious belief would be invaded or violated by the adoption of the proposed program."

There have been several other cases since 1952 culminating in June 1954 in the refusal by the Supreme Court of the United States to interfere with previous decisions of the California Court which upheld San Diego's legal right to fluoridate its supply of water.<sup>2</sup>

### 3. OBJECTION: Fluoridation is compulsory medication in that everyone is compelled to drink fluoridated water.

**APPRAISAL:** Lull,<sup>3</sup> Secretary and General Manager of the American Medical Association, has answered this objection directly. He has stated "It is claimed by some that the community has no right to force them to take undesired medication. This is a double-barrelled fallacy because, to begin with, fluoridation is not medication; it is adjustment to normal of a deficient fluorine content

in water in certain areas where needed. In the second place, no one is forced to use a public water supply; bottled water can be purchased. The public water supply is in the nature of a public utility, like gas, or electricity; it is a convenience but is in no sense a right. Although commonly run by the municipality, it may be a private enterprise in the same manner as electricity or gas which in some areas are publicly owned and in others, privately."

Dietz,<sup>5</sup> Assistant Attorney General, of the State of California, has analyzed the contention of compulsion to drink fluoridated municipal waters in relationship to constitutional guarantees of freedom. Dietz has stated that the freedom of belief is absolute whereas the freedom to act is not. Therefore, a person may think and believe as he wishes, for or against fluoridation. However, fluoridation does not limit his right to act as he sees fit. Specifically, there is no legal compulsion. The objector may drink, or not drink, fluoridated water, as he wishes. Dietz cited numerous decisions of courts to substantiate his conclusions. Black<sup>2</sup> cites numerous additional cases which support further this philosophy in court decisions, including one by the Supreme Court of the United States.

The evidence indicates clearly that fluoridation is neither medication nor compulsion and that the objection is invalid.

4. OBJECTION: Fluoridation constitutes "socialized medicine."

APPRAISAL: Previous appraisal, VI-1 and 3, have discussed the evidence by Dean,<sup>1</sup> Black,<sup>2</sup> and Lull<sup>3</sup> which shows clearly why fluoridation cannot be considered a medication. Therefore, as Black<sup>2</sup> has pointed out, since fluoridation is not medication, it cannot be considered the practice of socialized medicine.

5. OBJECTION: Administration of fluorides is morally wrong because it has not been proved safe beyond doubt.

APPRAISAL: The literature does not reveal any evidence or data which indicate that water, fluoridated at physiologic concentrations determined to be ideal for a local area, has proved to be unsafe or harmful in any way.

The scientific literature is replete with literally hundreds of articles reporting evidence which strongly substantiates conclusions of the effectiveness, safety, feasibility and general value of fluoridation of communal waters.

The St. Louis Medical Society<sup>8</sup> has evaluated thoroughly all evidence concerning fluoridation. Its committee concluded that "no evidence of injury to the well-being of any person, sick or well, infant or aged, has been related to fluorine present in water in physiologic concentration."

The New York City Board of Health<sup>7</sup> reported another evaluation of fluoridation. One of its conclusions stated, "A substantial body of scientific information attests to the achievement of substantial dental benefits without systemic harm to the body. There is no known health measure the safety of which has been subjected to as rigorous an investigation prior to adoption as has water fluoridation."

The National Research Council<sup>9</sup> has reported that "The adjustment of the fluoride content of drinking water to 1.0 p.p.m. fluoride is in principle and in practice the soundest and the most effective approach to caries prevention on a large scale known today."

The American Medical Association, through its Councils on Pharmacy and Chemistry and Foods and Nutrition, has expressed itself definitely to the effect that fluoridation is safe.<sup>3</sup>

The safety and soundness of fluoridation of water has led to its recommendation by all major national health-organizations.<sup>7</sup>

Studies lasting in excess of 10 years each have been completed in Grand Rapids,<sup>9</sup> Michigan, Newburgh,<sup>10</sup> New York, and Brantford,<sup>11</sup> Ontario. Each has had medical as well as dental evaluations. Each group of investigators was led to the conclusion, by irrefutable evidence, that fluoridated water is safe.

Studies of toxicity, vital statistics, analytical reports, balance studies, epidemiological findings, have been reported extensively in previous appraisals. All have shown that fluoridation is a safe procedure.

It would appear that the persons still in doubt about the safety of controlled fluoridation of communal supplies of water are those who have failed to study and analyze the voluminous evidence which is available.

6. OBJECTION: Fluoridation constitutes experimentation on human beings without their consent.

APPRAISAL: Doty,<sup>12</sup> Secretary of the Council on Dental Therapeutics of the American Dental Association, has discussed conditions for evaluation of safety of fluoridation. The conditions under which facts were learned about fluoridation were provided, not by human intent, or callous "experimentation," but rather by a circumstance of nature. Thus, nature itself has provided answers to the usual questions of the effects of administering fluorides in various concentrations and over long periods of time. Doty points out that approximately four million persons in the United States have, for many years, used drinking water containing the fluorine ion at concentrations of 0.7 to 3.0 p.p.m., or more.<sup>12,13</sup> In Texas alone over 60,000 individuals have used water containing from 3.0 to 5.0 p.p.m. of the fluorine ion.<sup>13,14</sup> Fluorine had been subjected to an extensive, although inadvertent field trial, before its nutritional

significance was recognized. To this enormous background of natural experience has been added the information derived from other investigations. The effects of drinking water, in which nature itself had placed 8.0 p.p.m. of fluorine, were studied carefully for 10 years in Bartlett, Texas.<sup>15</sup> Except for mottling of enamel, due to the excessive concentration of fluorine, no significant systemic or medical differences were found between the residents of Bartlett and the residents of Cameron, the fluoride-free city used as a control in these studies.

The question of "experimentation on human beings" was answered directly by the medical adviser to the Nuremberg Tribunal Commission. He advised that fluoridation of water can no longer be regarded as an experiment in the sense of the ten rules on human experimentation, which were stated during the Nuremberg Trials.<sup>26</sup>

7. **OBJECTION:** Fluoridation should be put to a referendum for all people in the city to decide.

**APPRAISAL:** Fluoridation of public supplies of water is a matter which requires scientific analysis and determination. When it has been concluded that fluoridation is desirable and feasible in a specific locality, support should be sought from the professional and health groups including the dental and medical professional societies, the health officer and his staff, nursing and pharmacist groups. Finally, a delegation representing the various professional and lay organizations endorsing the measure should present the proposal to the governing body of the community for its approval. The operators of the water plant should serve throughout as expert consultants on technical phases. All meetings and endorsements should be given wide publicity in the press and other media. Participation of people, based on informed opinion, should be encouraged.<sup>16</sup>

Counsel for the American Water Works Association<sup>4</sup> summed up the legal status of establishing local projects of fluoridation by stating that "the desirability of initiating or continuing fluoridation of a public water supply can properly and usefully be argued only before the local governing body."

A substantial number of people will be found untrained in making a scientific decision regarding the safety and value of fluoridation. To provide the citizenry with sufficient information for them to vote wisely is not feasible. In short, fluoridation should be legalized by action of the governing body composed of representatives of the people and not by the use of the referendum. No one will argue the political right of citizens to have an opportunity to vote on matters requiring such action. However, in America it has been traditional to delegate certain responsibilities requiring technical and professional knowledge to employed or elected representatives.

8. **OBJECTION:** The legal right of a community's government to fluoridate drinking water without the consent of the people has not been established.

**APPRAISAL:** The legality of fluoridating water has been tested by numerous judicial acts. Black<sup>2</sup> reports that the first five decisions of the courts were rendered in 1952. The cases concerned Northampton, Mass., San Diego, Calif., Chehalis, Wash., Baltimore, Md., and Fargo, N. D. All cases were decided in favor of fluoridation. Land and Mosenthal<sup>4</sup> have discussed details. In San Diego<sup>2</sup> the court rejected the argument that it was necessary for the defendant city to show that an emergency, epidemic or danger of contagion or infection existed. The court found, based on numerous precedents, that the city need only to show that the particular measure "was reasonably necessary to promote health," which it had done.<sup>2</sup>

The Supreme Court of the United States,<sup>27</sup> in 1955, refused to consider the case of Shreveport, La., in which the community's right to fluoridate was contested. The State Supreme Court of Washington<sup>27</sup> found that "Liberty implies the absence of arbitrary restraint. It does not necessarily imply immunity from reasonable regulation imposed in the interest of the community."

Numerous courts have defended the rights of legislative bodies to decide the matter of fluoridation of public supplies of water.<sup>4,27,28,29,30,31,32,33,34,35</sup>

9. **OBJECTION:** Fluoridation is another step in the socialization of the United States.

**APPRAISAL:** Socialization is a process of organizing the economic and political aspects of society on the basis of collective or governmental ownership and public collective management of the essential means for the production and distribution of goods.<sup>36</sup>

Fluoridation of water supplies is decided by the local governing body which consists of representatives of the citizens governed. The determination of whether to fluoridate or not to fluoridate is made by the community. Fluoridation is no more "socialized" than is chlorination or other measures employed by the community for the prevention of disease.<sup>26</sup>

Furthermore, fluoridation has the endorsements of all major national health organizations, such as the American Dental Association, the American Medical Association, and many other organizations which have opposed consistently any efforts which might lead to so-called "socialized medicine."<sup>37,38</sup>

10. **OBJECTION:** Fluoridation deprives people of their personal liberties and violates the freedom of personal care of one's own body.

**APPRAISAL:** Fluoridation does not exert

compulsion on the part of individuals any more than does the use of other resources of the community including chlorinated water. People form communities so that they can share such common public services as schools, fire departments, water supplies and libraries. If a separate group in the community wants a school that is different than that chosen by the majority then it establishes its own school. Hence, one group does not impose its convictions on the whole community. The same principle applies equally to supplies of water or milk. For instance, if a community wants its water fluoridated and its milk pasteurized, then fluoride-free water and unpasteurized milk can be obtained outside of the community by those who do not wish to use the community's water or milk.<sup>26,5,4</sup>

The Supreme Court of the United States apparently has settled effectively questions of the constitutionality of fluoridation in relationship to personal and religious freedoms. The Supreme Court on Dec. 6, 1954, decided to leave standing a ruling of the Louisiana State Supreme Court which upheld the constitutionality of fluoridation.<sup>39</sup> On June 7, 1954, the United States Supreme Court had declined to review a decision of the Supreme Court of California which upheld the right of San Diego to initiate fluoridation.<sup>39</sup>

Judge Artl, of Cleveland's Court, has ruled that "a person's constitutional right to treat his health as he deems best, and of parents to raise their children as they deem best 'to be free from medical experimentation and to exercise freedom of religion' are all subordinate to the common good."<sup>31</sup>

11. OBJECTION: Fluoridation is a political issue promoted by large pressure groups such as dental and medical societies and departments of public health.

APPRAISAL: The assertion indicates an inadequate knowledge of the objectives of professional groups. The dental and medical societies and departments of public health have endorsed and sought to advance fluoridation because the measure is proved scientific knowledge which can be applied to an urgent public-health problem.<sup>6,7</sup> The reduction by 60 per cent of the effect of dental caries is a matter which affects all people of a community.<sup>7</sup>

The endorsement of every major national health-organization has been given to fluoridation. Such an endorsement, in itself, is tangible evidence that fluoridation is a proved, safe and effective public-health measure.<sup>3</sup> The objection is an apparent device of those who oppose fluoridation to distort the meaning of endorsement by the most conservative and responsible health and professional organizations in the country. The truth is that these organizations strongly support fluoridation on the basis of the scientifically

demonstrated proofs of its value.<sup>7</sup> Instead of being a visionary political scheme, fluoridation has been shown to be a carefully considered recommendation of conservative professional organizations.<sup>38</sup>

12. OBJECTION: Dental caries is not contagious, so there is no legal authority to invoke the police power of the department of health to fluoridate.

APPRAISAL: No claim has been made by professional men or scientists that dental caries is a contagious disease. Neither has there been a claim by responsible health-officials or representatives of the scientific professions that fluoridation should be accomplished to prevent spread of contagion from dental caries.

The answer to the objection has been provided by the courts. Garvey,<sup>40</sup> Secretary of the Council on Legislation of the American Dental Association, testified before a congressional committee that the courts have decided eight cases which concerned the use of police power by the states. In each case the district judge decided that it was within the police power of the state to fluoridate water in the interest of the public health. One adverse decision (Chapman vs. The City of Shreveport) was appealed by proponents of fluoridation. The Supreme Court of Louisiana in setting aside the adverse district court decision, stated, in part, that "The fact that it (dental caries) is not a communicable disease and one that can cause an epidemic does not detract from its seriousness as affecting the health and well-being of the community. The plan for fluoridation, therefore, bears a reasonable relation to the general welfare and the general health of the community, and is a valid exercise of the power conferred by section 2.01 of the charter, if it is not arbitrary or unreasonable." The court found that it was not arbitrary or unreasonable, thus legally upheld fluoridation as a proper measure.<sup>40</sup>

One of the eight cases cited by Garvey<sup>40</sup> concerned San Diego, California. Black<sup>2</sup> also cited this case and pointed out that the court rejected the argument that it was necessary for the city to show that an emergency, epidemic, or danger of contagion or infection existed. The court found, based on numerous precedents, that the city need only to show that a measure "was reasonably necessary to promote health." In San Diego this finding was shown.

The Committee on Water Fluoridation of the St. Louis Medical Society reported that the power of a municipality acting through its elected representatives to initiate fluoridation of its water supply by legislative action has been upheld wherever challenged in court. Such a procedure is held to be proper exercise of the police power of the community to conserve or improve the health of its residents.<sup>6</sup>

13. **OBJECTION:** People who do not want fluoridation have to bear their share of the cost of fluoridation.

**APPRAISAL:** Measures which are approved by governing bodies of duly elected representatives of the public are supported by tax funds. It also is well-known that failure or unwillingness to support a worthy measure does not relieve the dissenter from his sharing the tax-liability. This conclusion applies equally to all activities in the public's interest which are supported by taxes.

Fluoridation is one of public-health's greatest bargains. The cost per capita has been reported to range from three to 20 cents per capita per year.<sup>2,41,42</sup>

Since nearly the whole population suffers from dental caries almost every child will benefit from fluoridation. Adult members of the community who translate the average of 60 per cent reduction of tooth decay<sup>43</sup> into savings on dental bills will find that fluoridation has saved, rather than cost, them money.

14. **OBJECTION:** Fluoridation is a communistic technic used to force totally un-American and vicious foreign ideology on the American people.

**APPRAISAL:** Hilleboe<sup>44</sup> has stated that "The progressive accumulation of dental disease . . . is a national calamity . . . . Water fluoridation is . . . an extension of standardized water treatment procedures designed to improve the health of consumers." Dean<sup>45</sup> has concluded that "fluoridation is a proven, effective, cheap and safe method for the partial control of dental caries." Russell<sup>46</sup> has said that ". . . the benefits of a fluoride water . . . continue into adult life without appreciable diminution with age." Leone<sup>47</sup> has stated, "We know without question or doubt, that one part per million of fluoride in a water supply is absolutely safe, is beneficial and is not productive of any undesirable systemic effect in man." Bronk,<sup>48</sup> has stated, "As President of the National Academy of Sciences I have full confidence in the integrity, reliability and scientific competence of these reports."

All major national health organizations have endorsed fluoridation of communal water supplies as a public health measure, in full support of the statements expressed in the preceding paragraph.<sup>49</sup>

Unsubstantiated and irresponsible charges should not be permitted to discredit the health-sciences and legitimate public-health progress.<sup>38,19</sup> This charge has not been supported by any evidence or data whatsoever.

The evidence for the benefits and safety of fluoridation has been developed with thoroughness and scientific accuracy over many years. In contrast to charges, made without proof or evidence, is the evidence for fluoridation that

can be obtained from about 5,500 scientific articles concerning the physiological effects of fluorine . . . a compilation by the Kettering Laboratory of the School of Medicine at the University of Cincinnati.<sup>2</sup>

15. **OBJECTION:** Fluoridation is a totalitarian measure since the government is sacrificing individuals for the good of the public.

**APPRAISAL:** The term "totalitarian" cannot be applied to the lawful establishment of fluoridation of water in the United States. Decisions by courts and official legal opinions have established that it is within the constitutional power of a municipality to fluoridate its water.<sup>2,4,5,40</sup>

Like any issue decided under American statutory authority, the process is entirely democratic, not totalitarian, since it is a function of government by the people or their elected representatives. People have used their right to vote specifically on fluoridation. Through 1953, 115 towns held referendums on fluoridation and a number rejected the measure. This right to decide an issue is not totalitarianism.

No evidence has ever been presented to show that any individual is being "sacrificed" or harmed in any way by the decision to add physiological concentrations of fluoride to drinking water.<sup>6</sup> Hundreds of scientific references have been cited in this report which point out in voluminous detail the benefits to be derived from such a health measure.

16. **OBJECTION:** The real purpose of fluoridation is to establish a legal precedent for compulsory medication for non-communicable disease.

**APPRAISAL:** Legal authorization of fluoridation is not in the same category as compulsory medication for non-communicable disease. In the first place, fluoridation is not medication at all. The purpose of medication is the treatment or cure of disease in some form. Dental caries is a non-healing lesion; dental enamel once injured never repairs itself, with or without medication. Fluoride simply prevents the decay from developing. Fluorides are not therapeutic agents added to water to treat or cure a disease. Fluorides help nature to build more resistant teeth.<sup>1,2</sup> Since fluoridation is not medication it cannot be considered as establishing a legal precedent for compulsory medication of any kind.

It is unnecessary, however, for a community to have a new legal device, as implied in the objection, to establish a precedent for medication of a disease, communicable or non-communicable. For example, when the court's decision was sought on fluoridation in the city of San Diego, the court found that a city need show only that "a particular health measure was reasonably necessary to promote health," in order to achieve a proper basis

for legal authorization. The court's finding was based on numerous precedents.<sup>2,4</sup> The court specifically rejected the argument that it was necessary for a city to show that an emergency, epidemic or danger of either contagion or infection existed.<sup>2,4</sup> Obviously, fluoridation is not essentially a legal technic to promote compulsory medication.

17. **OBJECTION:** If it is decided by plebiscite to fluoridate the water, an alternative source of water must be made available for those who do not wish to drink fluoridated water.

**APPRAISAL:** People form communities so that they can share such common public services as schools, fire departments, water supplies and libraries. No one is forced to use a public water supply. Bottled water, free of fluorine, can be obtained outside of the community. The public supply of water is in the nature of a public utility like gas or electricity; it is a convenience but in no sense a right. It may be managed either as a municipal or a private enterprise. In either case if a separate group wants a school that is different from that chosen by the majority than it establishes its own. The same principle applies to the supplying of water and milk. Therefore, if a community wants fluoridated water and pasteurized milk, the dissidents can obtain their fluoride-free water and unpasteurized milk outside of the community.<sup>3,26,4</sup> There is no legal compulsion to drink fluoridated water even though it becomes the community's drinking water.<sup>5</sup>

18. **OBJECTION:** Fluoridation of water does not adhere to the ten standards for experimentation on the lives of human beings adopted by the Nuremberg War Crimes Tribunal.

**APPRAISAL:** The American Dental Association<sup>50,26</sup> has reported an authentic explanation concerning this erroneous concept from Dr. Leo Alexander, Boston physician and a medical adviser to the Nuremberg Tribunal. Dr. Alexander wrote as follows: "In my opinion, the dragging in of our well-thought-out principles on human experimentation into the problem of fluoridation of water is a scurrilous bit of sophistry based on the distortion of the main fact, namely, that such a public health measure could possibly be construed to be human experimentation in the sense of those experiments to which our principles are to be applied. It seems to me that the basic part of the work on fluoridation that could be construed as experimentation had actually been done long ago by nature itself. From the literature submitted, it appears that a great many competent investigators have proven the fact that fluorine concentration of drinking water between 1.2 — 3.0 p.p.m., occurring naturally in many localities, is perfectly innocuous. Hence, the proposed

fluoridation of water can no longer be regarded as an experiment in the sense of our ten rules."

19. **OBJECTION:** Leaders, inspired by communism, are promoting fluoridation as a means of weakening the people of this country.

**APPRAISAL:** A search of the literature does not disclose any evidence whatever to substantiate this charge. Lull<sup>3</sup> and Danziger<sup>19</sup> have discussed the irresponsibility of such fantastic charges.

Apparently the assertion arises from the concept that fluoridation damages the brain and produces feeble-mindedness, that it will break down the "wills" of people, and that it makes them more susceptible to the propaganda of communists.

The evidence, attesting to the safety of the addition of fluorine ions to water in a dosage of approximately 1.0 p.p.m., is overwhelming. The Kettering Laboratory recently has compiled a list of 5500 separate references on the safety of fluoridation.<sup>2</sup>

The Water Fluoridation Committee of the St. Louis Medical Society, in its formal report of an exhaustive evaluation of fluoridation, stated that "no evidence of injury to the well-being of any person, sick or well, infant or aged, has been related to fluorine present in physiologic concentration."<sup>6</sup> The Committee studied all scientific investigations which have been made of fluoridation. These studies included analyses of vital statistics and experimental findings in man and lower animals. All studies confirmed the safety of fluoridation.<sup>6,2</sup> Similar conclusions concerning the safety of fluoridation have been reached in other extensive evaluations, among which are those reported by New York City's Board of Health<sup>7</sup> and the United Kingdom Mission.<sup>51</sup>

20. **OBJECTION:** Fluoridation interferes with medication in the home.

**APPRAISAL:** The fact that fluoridation is not medication has been discussed in several preceding appraisals. Dean<sup>1</sup> and Black<sup>2</sup> have shown that fluorides do not cure dental caries and are not applied for treatment. Fluorides are simply important aids to nature in building teeth which are more resistant to dental caries.

It may be that the assertion is intended to indicate that fluoridated water somehow interferes with the preparation or ingestion of medicines. If that is the intent, attention should be called to the formal endorsements of fluoridation by every major organization for health, including those pertinent to this discussion, namely, the American Dental Association, the American Medical Association, and many others.<sup>52</sup>

21. **OBJECTION:** A person's health is his own affair.

**APPRAISAL:** Land and Mosenthal,<sup>4</sup> while

discussing several decisions regarding fluoridation made by courts, cited the case of San Diego, California, as illustrative of the philosophy of the law. The Court's decision in this case stated, "Religious freedom embraces two concepts: freedom of *belief*, and freedom to *act*. The first is absolute, but in the nature of things the second cannot be, in that all acts or conduct of our citizens must conform to all reasonable regulations adopted by the respective governmental agencies acting within the scope of their authority."

Throughout the nation local governments have exercised their discretion to provide for the fluoridation of public water supplies. Their authority to do so has been recognized judicially on the basis of similar state and local public-health measures. In each instance where fluoridation has been attacked as arbitrary, capricious or unreasonable, or in violation of state or Federal Constitutional safeguards, it has been sustained by the courts.<sup>52</sup> As a specific example, the case in Louisiana may be cited. The court heard, as part of the case, the specific contention that fluoridation is a matter of personal hygiene (*Chapman v. Shreveport* 225 La. 859, 74 So. (2d) 142 (1954) appeal dismissed, 348 U.S. 892.) The court rejected the contention and stated "... the addition of fluoride to the water was not medicating it, in the generally accepted sense, but was adding to it one of the mineral properties found naturally in water in some sections of the country."<sup>52</sup>

22. **OBJECTION:** Fluoridation is a legislative measure to extend the omnipotence of the Federal Government.

**APPRAISAL:** Land and Mosenthal<sup>4</sup> discussed decisions by courts on the legality of fluoridation in five widely scattered states. They summarized the decisions as follows: "Based on the foregoing court decisions and the other available legal authorities, the only possible conclusion is that, upon compliance with local law, there is no legal obstacle to adopting and carrying out a fluoridation program. For this reason, it would appear that the decision of a legislative body on the matter is controlling and that the desirability of initiating or continuing fluoridation of a public water supply can properly and usefully be argued only before the local governing body." Black<sup>2</sup> reports that the record of all actions by courts to date may be summarized by stating that the power of a municipality to fluoridate its supply of water has been upheld by the courts in every instance where that power has been challenged.

It is of special interest to note that the U. S. Supreme Court refused to interfere with previous decisions of a California Court upholding San Diego's right to fluoridate its water.<sup>4,2</sup>

The Federal Government does not appear particularly omnipotent when one recalls that many local communities have used their legal

right to local referendums over the acceptance or rejection of fluoridation of their communal waters. Obviously, authority still rests locally with the people and their representatives.<sup>2</sup>

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## VII. LACK OF EVIDENCE OF VALUE

1. OBJECTION: No one, to date, has supplied proof that fluorine is essential to nutrition.

**APPRAISAL:** The Food and Nutrition Board, of the National Research Council<sup>1</sup> reported the following general statement concerning fluorides, as related to optimal intake of the elements of foods: "Fluorides are universally present in the earth's soil, and its plants and animals, including man. No one has so far been able to produce a fluoride-free diet, human or animal. Hence, while a certain amount of fluoride is obviously compatible with normal health, the minimum fluoride level conducive to optimal general health has not been determined."

However, as far as teeth are concerned, the Food and Nutrition Board<sup>1</sup> stated that the "optimum level of fluoride intake must at this time be defined as that which, in epidemiological and clinical observations has been found to combine the highest degree of caries protection with the lowest degree of mottled enamel. This level refers to the added amount of fluoride derived from drinking water containing or adjusted to contain 1.0 part per million of fluoride, assuming a basic dietary fluoride intake from average American foods which is relatively low but not necessarily constant or unchangeable."

The Board<sup>1</sup> states that "this fluoride level, while optimal for prevention of dental caries, is higher than would appear necessary to satisfy standard references of adequate nutrition, such as reproduction, growth and general health."

The extensive studies of numerous investigators have been discussed in detail in the various appraisals previously covered. The concensus on the safety of fluoridation has been presented by Leone<sup>2</sup> who stated that "We know without question or doubt, that one part per million of fluoride in a water supply is absolutely safe, is beneficial, and is not productive of any undesirable systemic effect in man."

One might conclude, if teeth are essential to maintain good health of individuals, then fluorides must be considered essential.<sup>1,3</sup>

2. OBJECTION: Fluoridation benefits children only.

**APPRAISAL:** Garvey<sup>4</sup> cites a specific decision of a court in discussing the legal status of the objection that fluoridation benefits children only. The Supreme Court of Louisiana rejected an argument that "It is unreasonable to fluoridate the water when it will reduce the incidence of disease only among a limited class." The Court found that "A health measure is not necessarily arbitrary because it affects primarily one class. It may, even so, be in the interest of the public generally. Ultimately, of course, the fluoridation will benefit the whole population because the retarding of decay extends into the adult life of the child who has had the benefit of water containing fluorides."

Numerous scientific studies have produced evidence that the caries-inhibiting effect of fluoridation continues into adult life in individuals who have used a fluoride-bearing water<sup>5</sup> during the developmental period or beyond. Deatherage<sup>6,7</sup> in the United States, as well as Heer and Galisier<sup>8</sup> in Argentina, arrived at this conclusion after examining young males of military age. Older adults were studied in the United States by McKay<sup>9</sup> and by Russell and Elvove.<sup>10</sup> In England, older adults were studied by Weaver<sup>11</sup> and by Forrest, Parfitt and Bransby.<sup>12,5</sup>

The several studies of Russell and Elvove<sup>10,13,14,15</sup> at Colorado Springs and Boulder, Colorado have demonstrated that the protective advantages of a fluoride-bearing water was not confined to childhood. Results of the study show that benefits continued into adult life without appreciable diminution with age, in persons who continued to use a fluoridated water supply after the period of formation of the teeth and their eruption. Through the

age of 44 years there were about 60 per cent fewer decayed teeth in the group using fluoride-bearing water. The non-fluoride group had lost three or four times as many teeth per person from all causes. Diseases of the gums and of the bone supporting the teeth were somewhat less prevalent in persons using the fluoride-bearing water. Extractions because of periodontal conditions were somewhat less frequent among adults in the community drinking fluoride in its water.

From the available evidence there appears to be excellent support for a conclusion that fluoridation provides benefits for persons of all ages.

3. **OBJECTION:** Artificial fluoridation may not produce the same results as do natural fluorides in the water.

**APPRAISAL:** Doty<sup>16</sup> has stated that "all fluorine is natural fluorine." Doty points out that if it is desired to test for fluoride in water the chemical procedures used seek, in either case, to determine hydrogen-ion concentration.

Recently, scores of the country's foremost chemists<sup>17</sup> presented a statement for publication in which they explained that fluorine is not manufactured but occurs naturally, and when combined with other elements, fluorides are formed. Fluorides in water dissociate into separately charged particles called ions. The chemists point out that the fluorine ion which occurs naturally in water is the same as the fluorine ion in water which results from *adding* fluorides under good chemical and engineering control for the prevention of dental caries; consequently, *there will be no difference in their effect in the human body.*

The results of numerous controlled studies previously discussed extensively have shown, after a period of over 10 years, that children drinking water fluoridated by man at optimal concentrations have received the same benefits which they might have expected had they been natives of a community in which nature had added the fluoride.<sup>5,18,19,20,21,22,23,24</sup>

The evidence shows unmistakably that the same results are obtained when using either "naturally occurring" or "controlled" fluoridation. The fluorine ion in the water is exactly the same chemically in either instance.<sup>25</sup>

4. **OBJECTION:** Fluoridation has not been recommended by the American Water Works Association.

**APPRAISAL:** This objection was answered directly by the Secretary and Chief Executive Officer of the American Water Works Association in a paper presented to a Congressional committee. Jordan<sup>25</sup> stated that the Association adopted in June, 1949, a statement of policy concerning fluoridation which read as follows:

"In communities where a strong public demand has developed and the procedure

has the full approval of the local medical and dental societies, the local and state health authorities and others responsible for the communal health, water departments or companies may properly participate in a program of fluoridation of public water supplies."<sup>26</sup>

Jordan,<sup>25</sup> in discussing the position of the Association declared that "It will be noted that the Association expresses no professional opinion concerning the merits of fluoridation — but states that it relies upon the opinion of trained physicians and dentists to advise local administrative authorities whenever it appears that fluoridation of a particular water supply is needed."

The statements make it obvious that the Association accepts its responsibility for standards of control of fluoridation, just as for other methods of treatment of water. However, the Association also feels that propriety indicates that professional judgment of bodily effects should be provided by local medical and dental authorities.

5. **OBJECTION:** Fluoridation is still in the experimental stage, and some experiments have produced contradictory results, e.g., experiments on human beings at Brantford, Ontario, show twice as much dental decay after a few years of fluoridation.

**APPRAISAL:** In science there is no such thing as final knowledge. New information is continuously developed even about such accepted procedures as pasteurization of milk and chlorination of water. All evidence on fluoridation, as on these other health measures, attests the safety and effectiveness of the measure for the partial control of dental caries.<sup>27</sup>

The assertion that fluoridation has resulted in twice as much dental decay is not supported by facts. The final report<sup>28</sup> of the 10 years' study of fluoridation at Brantford compares the prevalence rates for cavities before and after this prolonged period. The DMF (decayed, missing, filled) rate in permanent teeth dropped 60 to 66 per cent in the six- and seven-year-olds, and 34.5 per cent in the 15- and 16-year age-groups. The average drop, after fluoridation, had been in effect for 10 years, was 53.9 per cent in permanent teeth. These reductions were recorded as a result of examinations of 5,164 children in 1944-1945, and 3,133 examined in 1955, aged 6 through 16, according to the final report of the study at Brantford. Other studies have provided close corroboration of these findings.<sup>19,20,22,23,24</sup>

There is no known measure for protecting health, including chlorination of water, pasteurization of milk, or vaccination against small pox, which has had the intensive and comprehensive study prior to its adoption as has fluoridation of water.<sup>29,30,31</sup>

6. **OBJECTION:** No one is sure that fluorine is the

element responsible for lower rates of dental decay.

**APPRAISAL:** Dean and his associates<sup>32,33,34</sup> conducted epidemiological studies in which they examined more than 6,186 children aged 12 to 14 years. These children were lifelong residents of 21 cities in which the drinking water contained from 0.0 to 2.6 p.p.m. of fluorine. The results of the study showed that children using the water containing fluorine had the least amount of cavities. Dean<sup>35,36,37,38,39,40,41</sup> and Dean and Elvove<sup>42,43</sup> have shown that the inhibition of caries takes place even at levels below a concentration which will produce mottling of the enamel.

Hodge<sup>44</sup> and Cox and Hodge<sup>45</sup> observed optimal effects of fluorides to be at 1.0 p.p.m., as first established by Dean and Elvove.<sup>42</sup> Pelton and Wisan<sup>5</sup> have discussed these findings and have pointed out that the optimal effects of concentrations of fluoride at about 1.0 p.p.m. have been confirmed by numerous investigators in many parts of the world.

The long-term studies at Grand Rapids, Michigan,<sup>19</sup> Newburgh, New York,<sup>20</sup> Brantford, Ontario,<sup>21</sup> Evanston, Illinois,<sup>22</sup> and other areas<sup>23,24</sup> have constituted highly practical demonstrations that fluorine is the element responsible for lower rates of dental decay.

7. **OBJECTION:** The American Medical Association did not give an unqualified endorsement of fluoridation of drinking water.

**APPRAISAL:** A resolution of the House of Delegates of the American Medical Association at its Annual meeting in 1951 endorsed the fluoridation of water supplies. The American Medical Association's Secretary stated that the House of Delegates did not "urge" adoption of the dental measure and explained that "it was the opinion of the Council (on Pharmacy and Chemistry) that this question (of recommendation for or against) should be answered by the dental profession." The American Medical Association's statement of policy concludes that "fluoridation of water supplies in a concentration not exceeding one part per million is non-toxic and its principle is endorsed."<sup>46,47,48</sup>

The American Medical Association also approved a resolution of the Inter-Association Committee on Health, of which it is a member, which reads: "Resolved, that the Inter-Association Committee on Health urges the fluoridation of the fluoride-deficient public water supplies of this country as rapidly as plans can be approved by local medical, dental and health department officials and the state departments of health."<sup>49</sup>

In 1955, four years after the original American Medical Association's endorsement of fluoridation, the Association's Secretary and General Manager<sup>50</sup> answered the basic objection in quite

specific terms. He wrote: "The unscrupulous opponents of fluoridation have spread the impression that the American Medical Association did not endorse this public health measure. The fact is that they did and that it stands by its endorsement. It is true that the endorsement did not urge any action whatsoever upon responsible officials because that is not the function of the Association. Both the A.M.A. Council on Pharmacy and Chemistry and the A.M.A. Council on Foods and Nutrition expressed themselves definitely to the effect that fluoridation is safe. If this is not an endorsement — what is it?"

8. **OBJECTION:** Many of the groups which endorse fluoridation merely are parroting each other's opinions, and they have completed no original research themselves.

**APPRAISAL:** This assertion may be questioned for being misleading. The groups which endorse fluoridation are the country's foremost scientific health-organizations and official bodies. Among these groups are the National Research Council, the U. S. Public Health Service, the American Dental Association, the American Medical Association, the American Public Health Association, the Association of State and Territorial Health Officers, and many other organizations.<sup>30</sup>

The evidence now in existence concerning safety, effectiveness, physiological actions, epidemiological considerations and engineering aspects has been determined by studies of members of these organizations or other health organizations which endorse fluoridation. The conclusions of these agencies reflect the expert knowledge of their individual members who have taken part in the original investigations relating to fluoridation.<sup>30,51</sup>

The evaluations of fluoridation made by such organizations as the American Dental Association and the American Medical Association were accomplished by councils composed of many of the Nation's outstanding dental and medical scientists.<sup>27,52</sup>

The scientific literature is voluminous with facts concerning fluoridation. For example, a listing of more than 5,000 separate reports on the subject has been compiled by the Kettering Laboratory in the Department of Preventive Medicine and Industrial Health, College of Medicine, University of Cincinnati, Cincinnati, Ohio. The list is entitled "Classified Bibliography of Publications Concerning Fluorine and its Compounds in Relation to Man, Animals and Their Environment, Including Effects on Plants."<sup>53</sup>

The literature which attempts to provide scientific data to support assertions of anti-fluoridationists is virtually non-existent.

9. **OBJECTION:** The statistical evidence alleged to support the hypothesis that fluorides reduce the

incidence of dental caries is invalid because biased dental examiners and improper statistical methods were employed.

**APPRAISAL:** The studies in Grand Rapids, Newburgh and Evanston are among the outstanding studies which have demonstrated that fluorides in drinking water, at a concentration of about 1.0 p.p.m. reduce the incidence of dental caries.

Arnold, Dean, and Knutson<sup>54,19</sup> and Dean, Arnold, Jay and Knutson<sup>55</sup> have reported their methods of examination and analysis. Detailed dental examinations were made of virtually the entire population of the schools of Grand Rapids and Muskegon, Michigan, and Aurora, Illinois, whose children had been in continuous residence. The dental examinations were made using a mirror and explorer and with good lighting. The data were compiled by use of a precoding system which permitted direct transfer of dental findings to punch-cards. Processing of data then could be handled with mechanical devices. The comparability of observations was planned by using a control city, Muskegon, Michigan, whose source of drinking water and geographical and climatological characteristics were similar to those of Grand Rapids. Bite-wing radiographic examinations were made of a representative sample of children examined by different examiners to evaluate, in part, the "examiners' errors." In addition to a completed oral examination, a history of residence was obtained, which for the younger children, was verified by a questionnaire signed by parents or guardians. Base-line and periodic follow-up data were obtained. Statistical evaluations were made using "DMF" as an index for permanent teeth, and "def" as the index for deciduous teeth.<sup>54</sup> The reduction of incidence in dental caries, in terms of the average number of teeth attacked by caries, is of the order of 60-65 per cent.<sup>56</sup>

In the study of Evanston, Illinois,<sup>22</sup> dental examinations were conducted each year in the Evanston schools. Radiographs of all teeth were secured for each child. Categorization and tabulation of the data were used to prepare code-sheets and punch-cards. These items were provided by the Department of Vital Statistics of the Illinois State Department of Health. All clinical examinations of teeth were performed by staff-dentists and all information pertaining to the dental findings were studied by the dental members of the project, whereas the statistical evaluations were made by a competent statistician. Standards were established and followed for comparability of data. For example, in the 1955 examination, before the dentition of children between 6 and 8 years was considered to be "caries-immune," the mouths not only had to be free of carious lesions and fillings in the deciduous teeth, but the finding had to be confirmed by radiographs. Six anterior

periapical films and two posterior bite-wings were required to show all proximal areas.

Ast and his associates<sup>20</sup> have reported that all examinations in both public and parochial schools of Newburgh and Kingston, New York, were made by one staff-dentist, using a mirror and explorer. Recording was made according to an established classification which indicated caries-free teeth, untreated cavities, filled, missing and unerupted teeth. The status of every tooth was noted on the chart. The age-adjusted DMF rate in these base-line examinations was about 20 DMF teeth per 100 permanent teeth in both Newburgh and Kingston. The rate for first permanent molars was approximately 58 DMF per hundred erupted first molars in each city. Over the 10 years of the study all reports of progress showed a continuing downward trend in the caries-experience among Newburgh children, whereas the reports showed little change in caries-experience among Kingston children.

The chief of the Bureau of Health Services in the State Department of Education of New York replied to a question concerning the validity of the findings of the dental examiners and the statistical methods used in the study of Kingston and Newburgh. Frost,<sup>57</sup> as chief of the Bureau, stated that the data concerning the number of children with dental defects which appeared in the annual report of the State Department of Education cannot be compared with the statistical tabulation on caries-experience reported by the State Department of Health in the study of Newburgh and Kingston because of two reasons: first, in Kingston, the State Health Department used physicians to examine for oral defects and these men used only a tongue blade, while in Newburgh it was performed by dental hygienists using mirrors and explorers; (therefore, the thoroughness of inspection was different; Newburgh reported more defects). Secondly, the reporting of defects insofar as the State Department of Education was concerned, also differed radically from the type of reporting used by the State Department of Health in its study of Newburgh and Kingston. The State Department of Education indicated the number of children with some oral defect, but not the number of defects per child.

10. **OBJECTION:** The best teeth are found in areas where there are no fluorides in the water.

**APPRAISAL:** There is no evidence in the literature to support such a belief. There is definite proof that an inverse relationship exists between the prevalence of dental caries and the presence of fluorides in the drinking water.

McKay<sup>58</sup> noted that mottled teeth were caused by something in the drinking water. He also learned, despite the mottling of these teeth, that they were not more susceptible to dental caries. McKay reported that residents of areas, where

there was endemic mottling of teeth, experienced less cavities than persons who lived where mottling did not occur.

The agent responsible for the lowered experience with caries was identified as fluorine, in 1931, and methods for measuring its concentration were developed by 1933. The DMF index for expressing the experience with dental caries in quantitative terms was evolved in 1934. All of these means made possible the quantitative study of the caries-fluorine relationship.<sup>5</sup> The comprehensive studies of Dean and his associates<sup>33,34,35,43</sup> followed. The studies demonstrated in nearly 7,000 children who were life-long residents of 21 cities that an exact relationship existed between the extent of cavities in children and the amount of fluorine in the drinking water consumed. Children who drank water containing fluorine exhibited the least number of cavities. The caries-inhibiting effect was exerted at levels of fluoride too low to cause objectionable mottling. The optimal effects were produced at a concentration of about 1.0 p.p.m. of fluoride<sup>44,45,5</sup> in the drinking water.

The evidence cited indicates clearly that residents of areas drinking water fluoridated to physiologic concentrations either by nature or by man will experience a lower rate for cavities and hence "better" teeth than those in fluoride-free areas. Drinking water containing fluorine in excess of the recommended concentrations will produce unesthetic mottling of the enamel.

11. OBJECTION: The so-called benefits of fluorides in areas of the Southwestern part of the United States are not due to the fluorides in the water but to the great amount of minerals in the soil.

APPRAISAL: The National Research Council<sup>59</sup> has reported studies of the ability of foods to serve as vehicles for the ingestion of fluoride. No important difference was found between the content of fluorides in diets consumed in Cincinnati, Ohio, and in Arizona and New Mexico. Clifford<sup>60</sup> observed that wheat grown in Deaf Smith County, Texas, a high-fluoride area, did not contain a significantly higher percentage of fluorine than wheats grown in other areas. This finding obviously does not support the assumption of the objection that the minerals in the soil are consumed through food rather than water.

McClure's<sup>61</sup> studies of the intake of fluoride by children one to 12 years of age resulted in calculations that their food contained from 0.1 to 1.0 p.p.m. of fluoride on a basis of dry-weight and that the children in the age-group studied had an intake of fluoride that varied from 0.03 to 0.56 mg. of the element daily. McClure noted that items which contained large amounts of fluoride, such as seafoods and tea, did not occur in appreciable quantities in children's diets. Therefore, foods do not appear to contribute fluorides in

amounts adequate to explain the benefits observed in the Southwest.

The studies, published by Dean and his associates,<sup>32,33,34,38,43</sup> have shown the inverse relationship between dental caries in children and the fluoride ion in communal drinking waters. McKay,<sup>62</sup> as early as 1918, had studied the relationship of geological formations to the defect called mottled enamel. Nichols<sup>63</sup> noted that subsequent chemical studies linked McKay's epidemiological findings with the geological deductions by Washington<sup>64</sup> that fluoride present in parts of Texas and other areas of the Rocky Mountain watershed may be derived from drainage from igneous rocks of the Rocky Mountains.

Nichols<sup>63</sup> pointed out that waters on or in the earth's crust are found to contain fluorides which have become dissolved from the minerals of the earth through contact with the water. The concentration of fluoride present in the water depends upon the availability and solubility of the minerals in or on the crust of the earth. Since the soils of the Southwest contain considerable amounts of minerals it is not surprising to find many waters fluoridated naturally. Some of these supplies of water contain concentrations of fluoride in excess of levels considered ideal for the reduction of the incidence of dental caries. Bartlett, Texas<sup>65</sup> had 8.0 p.p.m.

The evidence available leaves no doubt that water is the major source of the fluorides responsible for benefits to dental health.

12. OBJECTION: The reported beneficial effects of fluorides may be produced by some other factor such as the presence of magnesium or calcium in the water.

APPRAISAL: Dean and his associates<sup>33-42</sup> demonstrated, by the most scientific methods, that fluorides produce beneficial effects on dental health through the reductions in the incidence of dental cavities. These benefits are not speculations but proved facts from evidence produced by comprehensive epidemiological,<sup>33-42</sup> chemical,<sup>44,45,66</sup> and animal studies.<sup>67,68,69</sup>

Sobel's findings in vitro concerning relationships between fluorides and magnesium may have been the basis for the assertion being appraised. The American Dental Association<sup>27</sup> has quoted Dr. Sobel as stating that there is no justification for concern about a detrimental effect of lack of magnesium on the effect of fluoridation to prevent caries. The American Dental Association<sup>70</sup> also reports that Sobel's findings in test tubes have not been duplicated in the experience of human beings or animals and provide no evidence that magnesium has any influence on the beneficial effect of fluorides.

The only effect of magnesium reported in the literature concerns the softening of hard waters by lime, as advocated by Scott, Kimberly, Van

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- Horn, Ey, and Waring,<sup>71</sup> in which the actual removal of fluoride was found to be a function of the amount of magnesium removed. The chemical process has been described by Zettlemoyer, Zettlemoyer, and Walker.<sup>72</sup> Maier<sup>73,74</sup> states that the reduction of fluoride with lime was actually a function of the amount of magnesium removed. Between 45 and 65 p.p.m. of magnesium must be removed to reduce the fluoride to 1.0 p.p.m. The removal of fluorides by magnesium has practical significance only in procedures for softening water or defluoridation at water plants. It had no direct relationship whatsoever with the ability of ions of fluorine to serve as the caries-preventive agent in communal drinking water. Neither magnesium, nor calcium have been shown to have any capacity to reduce dental caries.
13. **OBJECTION:** Evidence supporting the value of fluoridation is presumptive as is all epidemiological evidence.
- APPRAISAL:** The objection indicates that fluoridation has limited its evidence to epidemiological studies. Although the studies accomplished by Dean and his associates now are recognized as scientific classics in the study of fluoridation, the rationale of fluoridation rests on numerous investigations of other areas of interest which bear directly upon the evaluation of the use of fluorides. For example, the epidemiological studies by Dean and associates,<sup>32-44,55</sup> the balance-studies by McClure and associates,<sup>75-79</sup> and the chemical and animal studies by Hodge, Cox, Smith, Heyroth and Armstrong<sup>44,45,68,69,105,66,67</sup> are of great significance. Then the all-important long-term studies, each lasting in excess of 10 years, were completed with large communities. Excessive concentrations<sup>65</sup> as well as optimal concentrations<sup>19,20,21,22,23,28,56</sup> of fluorides in communal drinking waters were evaluated. Vital statistical studies<sup>60,81,82,2</sup> were completed. Finally, independent evaluations were conducted of all aspects of fluoridation and summarized into comprehensive formal reports by the St. Louis Medical Society<sup>29</sup> and the New York City Board of Health.<sup>30</sup>
- It is truly remarkable that, without exception, all types of studies, investigations and analyses led to the unanimous conclusion which was summarized concisely by the National Research Council:<sup>56</sup> "The adjustment of the fluoride content of drinking water to 1.0 p.p.m. is in principle and in practice the soundest and most effective approach to caries-prevention on a large scale known today."
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## VIII. OTHER OBJECTIONS

1. OBJECTION: Fluoridation is being promoted for the purpose of selling equipment and chemicals.

APPRAISAL: Tossy<sup>1</sup> has discussed the costs of installing equipment in communities of various sizes. He states that four gravimetric dry feeders would be required for large cities such as the Detroit metropolitan area. Including installation, four feeders would cost about \$14,000; this estimate includes a cost per unit feeder of \$2500 with \$1000 as the installation expense. Feeders should last about 20 years and the cost can be amortized over a period of 10 years or more.

For smaller cities a liquid feed or hypochlorinator type of equipment is suitable. It can be purchased in duplicate and installed at a total cost of about \$1200.00.

Tossy<sup>1</sup> has reported that the annual cost of fluoridation per capita is the approximate cost of one pound of sodium fluosilicate or sodium silicofluoride, as it is known commercially. This amount is only about 3.5 cents per pound. With a life expectancy of 70 years, it is of interest to note that the total cost per individual for a lifetime reduction of about 67 per cent in his prevalence of cavities amounts to about \$2.10.

These low figures quoted by Tossy are supported by other estimates of cost as stated by the Inter-Association Committee on Health.<sup>2</sup> The Committee stated that the cost of equipment for a city of 2,500,000 persons was about \$15,000 whereas the costs for smaller towns would require several hundreds of dollars. Annual operating costs will vary from 4 to 14 cents per person. The Inter-Association has six organizations in its membership. They include the American Dental Association, the American Medical

Association, American Public Health Association, American Public Welfare Association, American Nurses Association, and the American Hospital Association.

With a normal lifetime of 20 years and a modest initial cost to be amortized over a long period, equipment will yield relatively small profits to commercial interests. The sale of fluorides to water plants does not constitute a commercial bonanza. The accusation included in the objection has been admitted by the antifluoridationists to be untrue. James Rorty who wrote a hypercritical article in Harper's Magazine stated it as follows: "... the program at best would yield relatively slim pickings to commercial interests... whether fluoridation is safe or not may be left for further research to determine, but it is certainly cheap."<sup>3</sup>

2. OBJECTION: Fluoridation is being promoted to provide a profitable method of disposing of cryolite saturated with fluorine, a waste product of the aluminum industry.

APPRAISAL: The American Dental Association<sup>4</sup> cites information which shows that the fluorides used for fluoridation of water supplies are not a by-product of aluminum plants. The Aluminum Company of America in correspondence with the American Dental Association has stated that it does produce sodium fluoride but in a special plant in the same manner as this fluoride is produced by others not in the aluminum industry.<sup>5,6,7</sup>

This type of assertion is one of those irresponsible and baseless charges to which Dr. G. F. Lull, Secretary and General Manager of the American Medical Association has referred. Lull<sup>8</sup> calls attention to such charges as the one that

responsible scientists and public officials have been "bought." In reply to this assertion Lull states that "The ridiculousness of such a charge evaporates into thin air when one merely looks at the official and professional bodies that have endorsed fluoridation." These organizations include, Lull has pointed out, the National Research Council, the U. S. Public Health Service, the Association of State and Territorial Health Officers, the American Dental Association, the American Medical Association, the American Public Health Association, and the Commission on Chronic Illness.

3. **OBJECTION:** Fluorides cause water to have an objectionable taste and smell and fluorides in the water change the taste of coffee, tea and foods.

**APPRAISAL:** Fluoride does not impart objectionable flavor either to foods or to drinks. The American Water Works Association<sup>9</sup> has reported that fluoridation does not affect the taste, odor, color or turbidity of water.

There is considerable evidence that the taste of liquids or food is not affected by addition of fluoride to water. Cox and Nathan<sup>10</sup> conducted a study in which they used 187 male students and found that only eight in the group could detect 10 p.p.m. of fluorine ion (as sodium fluoride) when present in distilled water. Only one in the entire group of 187 could detect 2.4 p.p.m. These tests were made with distilled water; with 100 to 300 p.p.m. of dissolved solids the ionic effect on taste would be somewhat obscured. Cox and Nathan demonstrated that fluorine ions at 1.8 p.p.m. would be entirely tasteless and that the average person would not be able to detect any taste when ten times the usual 1.0 p.p.m. was present.

Another experiment testing taste was conducted by Cox.<sup>11,12</sup> He had 280 young men taste, without swallowing, two solutions. One solution was distilled water, whereas the other was distilled water containing 133 p.p.m. of fluorine. Even at this high concentration 142 of the 280 men failed to detect any difference in taste between the solutions.

Tea contains a high concentration of fluorine. A cup of high-grade tea will contain as much as 75 to 100 p.p.m.<sup>13</sup> Hence the fluoride present in the water contributes only a small fraction of the total fluoride present. Black<sup>14</sup> stated the consensus of scientific opinion that "In the concentration of 1.0 p.p.m. employed in fluoridation, none of the chemicals has any effect on the taste of the water."

An extensive review of hundreds of scientific articles on fluoridation has revealed no studies, data, or evidence which would support a belief that fluorides cause objectionable odors or tastes in liquids or foods.

4. **OBJECTION:** Pro-fluoridationists are using the "big-lie" technic in promotion.

**APPRAISAL:** The allegation that fluoridation is being promoted on the basis of lies is easily refuted. Doty<sup>15</sup> refers to the "big-lie" term and points out that the basis of the statement is the old charge that there has been little study of factors relating to fluoridation. Doty<sup>15</sup> and Black<sup>14</sup> suggested, in 1953 and 1955 respectively, that this charge should be contrasted with the accumulation of about 5,000 titles of scientific articles bearing on the effects of fluorides which appear in the list<sup>16</sup> compiled at the Kettering Laboratory at the University of Cincinnati School of Medicine. Dean,<sup>17</sup> has called attention to the continuing progress of scientific studies of fluorides by reporting that the Kettering Laboratory's list at the present time (1957) has been expanded to a bibliography of over 8500 references. The American Dental Association<sup>18</sup> has referred to this list and a similar bibliography of 1400 references compiled by the University of Rochester for the Atomic Energy Commission.

Weiss<sup>19</sup> has indicated that the role of the community should be an active one. The community should retain the right of directing and controlling its own destiny. Therefore, fluoridation must be related to the objectives of the community, must allow for initiation and participation by community-wide support. For these reasons, communities should be encouraged to share the responsibility of initiating the program. Participation should augment support by the community. The content of the pre-fluoridation program should consist partly of methods which consider the inherent desires of the public and partly of factual information.

The National Research Council<sup>20</sup> has stated that "The promotion, initiation, supervision and proper operation of the fluoridation of public water supplies is a responsibility of the state department of health, acting jointly through its bureau or division of dental health and through the division of public health engineering with the collaboration of the dental and medical professions. Suitable local plans for dental health surveys before fluoridation and periodic evaluations should be set up by the dental public health program director. These surveys should provide data suitable for calculating an index of caries attack and an index of the frequency and severity of dental fluorosis. Engineering aspects of fluoridation, such as tests to determine the fluoride content of the water, safety provisions, training of operators, etc., should be covered by state regulations."

Doty<sup>15</sup> points out the lack of evidence supplied by the antifluoridationists when he states: "In no instance has anyone demonstrated undesirable effects (of fluoridation) except with regard to

mottled enamel in those areas where the fluoride concentration is distinctly higher than that recommended in controlled fluoridation."

5. **OBJECTION:** Fluorides in the water cause women difficulty in the management of their hair.

**APPRAISAL:** An extensive review completed of hundreds of scientific articles does not disclose a single reference to indicate that fluorides in water are related in any way to difficulty in management of the hair. No evidence has been presented by those who have made the assertion. Therefore, it must be concluded that the assertion is merely supposition and not founded on factual data.

6. **OBJECTION:** In response to the appeal of fluoridation, dentistry's great nutritional emphasis was lost.

**APPRAISAL:** The Food and Nutrition Board of the National Research Council<sup>21</sup> made a study of the problem of providing optimum intake of fluoride for the prevention of dental caries. Part of this study included evaluation of the various vehicles for the ingestion of fluorides, including the use of foods and liquids. Fluorine at a level of about 1.0 p.p.m. in drinking water was reported to provide the best technic for supplementation of one's diet. There is a satisfactory regulation of the total intake of such fluoridated water, whereas there is no evidence to show, according to the National Research Council, that fluorides added to other items of the diet would be self-limiting and self-regulatory. The Council also stressed that water as a vehicle for fluoridation is the only carrier which can be judged on the basis of observations as well as clinical applications.

If it is suggested that good nutrition alone will prevent caries, it must be noted that evidence does not support the contention. Jay<sup>22</sup> has stated that it is not at all uncommon for teeth to decay in individuals who are well-nourished insofar as clinical and laboratory tests can determine. Jay points out that the only chemical difference between carious and caries-free teeth was demonstrated by Armstrong and Brekhus<sup>23</sup> who found the mean content of fluorine in enamel of sound teeth to be greater than that of carious teeth.

Cady,<sup>24</sup> and Messler and Schour<sup>25</sup> reported that studies of malnourished children in Europe revealed a much lower rate of dental decay than was found among children in the United States who appeared to be well-nourished. Marshall-Day<sup>2</sup> found a similar low rate for caries in a famine area of India where nearly 75 per cent of the 12-year-old children were free of cavities. This situation is in marked contrast to that in Rochester, New York, where less than one per cent of the children were found to be free of cavities. Marshall-Day concluded, from his findings, that teeth do not share in the general

bodily deterioration which accompanies dietary deficiencies.

There is no doubt that the overwhelming weight of competent scientific opinion is that fluoridation of water is an effective, safe, practical and much-needed procedure in public-health practice.<sup>27</sup> Although human nutrition will provide traces of fluorides, it is only with the additional fluoride obtained from water that substantial dental benefit has been achieved.<sup>27</sup> Overwhelming evidence attests to about a 60 per cent reduction in dental decay among those who have consumed water naturally fluoridated or mechanically supplemented.<sup>28,29,30,31,32,33</sup> Further evidence<sup>34,35</sup> has shown that this protection is maintained at least through age 44 and throughout life.

Since no other procedure approaches the fluoridation of water in dependable effectiveness<sup>21,27</sup> it seems that it would be for the better, indeed, if more emphasis were to be placed on fluoridation as the ideal method for the ingestion of fluoride in physiological amounts.

7. **OBJECTION:** Any sensible person knows that the way to improve dental health is give the children plenty of milk, and a balanced diet and not fluorides.

**APPRAISAL:** Milk contributes the calcium necessary for bones and teeth. However, there is no evidence that milk can prevent dental caries as a substitute for fluorine. Robinson<sup>36</sup> states that calcium and vitamin D have not controlled dental caries and "there is no physiologic basis for assuming that they will." Robinson<sup>36</sup> and Kronfeld<sup>27</sup> have concluded, after teeth are fully formed and erupted, that they cannot incorporate more calcium in the enamel systemically.

While it is true that some fluorides are available in the diet, the evidence indicates clearly that additional fluoride must be obtained for the dental benefit to be substantial.<sup>27,21</sup> The lack of effectiveness of good nutrition alone as a preventive of dental caries have been discussed, and the evidence cited, in the appraisal of the objection immediately preceding this one. They are equally pertinent to this appraisal.

The National Research Council<sup>21</sup> has pointed out that fluoride in water is the only method which can be evaluated on the basis of prolonged epidemiological observations as well as clinical application. The National Research Council, after an exhaustive study of providing an optimum amount of fluoride in the American diet, came to the conclusion that "The adjustment of the fluoride content of drinking water to 1.0 p.p.m. of fluoride is, in principle and in practice, the soundest and most effective approach to caries prevention on a large scale known today."

8. **OBJECTION:** Dentists have evaluated programs of fluoridation and made statements about general

health; only a physician should make statements about general health and non-dental diseases.

**APPRAISAL:** Facts are obtained through scientific research by various members of the health-disciplines and organizations. Facts on fluoridation have been provided by long- and short-term research studies of scientists who also were dentists, physicians, epidemiologists, bacteriologists, chemists, bio-chemists, engineers, statisticians, and auxiliary personnel who assisted these leaders.<sup>28,29,30,31,32,13,14,15,20,21,22,23</sup>

Facts developed by the teamwork of health-scientists are equally available for the use of all professional and official leaders who wish to employ such information in developing programs of fluoridation.

Medical facts relating to fluoridation are used as properly and freely by the dental profession as dental research findings are used by the medical profession. Fluoridation of water supplies is endorsed by both the American Medical Association and the American Dental Association, and all other major national health-organizations.<sup>4</sup>

9. **OBJECTION:** Kahn and Wasserman tests for syphilis cannot be made with fluoridated water.

**APPRAISAL:** Kahn<sup>38</sup> states that this assertion is true; that distilled water is used to prepare the physiologic salt solution employed in his test for syphilis. Moreover, Kahn has stated that distilled water has been used for all such serological tests, including Wasserman's. Tap water never is used, regardless of whether or not the water is fluoridated. Kahn states further that water used for the laboratory tests must be entirely free from all traces of chemicals of all types. It is simply a routine measure to use distilled water in such a laboratory.

10. **OBJECTION:** If fluoridation had value, personnel in public-health departments would not need to promote it since the people would demand it.

**APPRAISAL:** Knutson<sup>39</sup> has stated that the Public Health Service is charged by law to conduct research in health-practices, to develop and test measures for the prevention and control of disease, to help states and communities apply those measures, and to disseminate public-health information. The job of the public-health person is to help apply the findings of research and laboratories for the benefit of all of the people. The effects of fluoridation have been demonstrated, checked and then rechecked.

Knutson,<sup>39</sup> also has pointed out that "the responsibilities of the Public Health Service are clear: to make the facts about fluoridation known to state and local health agencies and to provide them with technical assistance in the application of this important public health advance. As with

all public health procedures the decision on fluoridation rests . . . with the local community." The philosophy expressed by Knutson is that "in fluoridation, as in other health matters, the combination of professional public health leadership and enlightened citizen interest will ensure the decision that will enable communities to go forward in health."

Black<sup>40</sup> and Faber<sup>41</sup> indicate that society has the right to expect that those things should be done which contribute to the public welfare, provided they are reasonable and practical. Decisions on matters of major policy which affect the public welfare should be made by those professions or groups most qualified from the standpoint of training and experience to make them.

The responsibilities of the public-health person, therefore, include research to learn about better health, then to develop measures which will prevent or control diseases, and to help with the application of specific programs by technical assistance and dissemination of information. Public-health personnel actually are the representatives of the people's government charged by law to promote matters of health for the general welfare. In promoting fluoridation as a public-health measure, the health-professions simply are fulfilling their legal as well as their professional responsibilities to the people.

11. **OBJECTION:** Dental decay can be reduced sufficiently by the restriction of sugars in the diet, therefore, fluoridation is not needed.

**APPRAISAL:** The dietary approach to restricting consumption of readily fermentable carbohydrates, particularly sweets, has been demonstrated to be highly effective.<sup>22,42,43,44,45</sup> Through such dietary restriction dental decay virtually has been eliminated under experimental conditions. From a practical viewpoint, however, years of dental-health education have not been effective in reducing the inclusion of desserts, candies and other sweets in the American diet. It appears that the undramatic nature of dental decay cannot compete successfully, on a large scale, with America's "sweet tooth."

Fluoridation of water has been demonstrated to be, both in principle and in practice, the soundest and most effective approach to prevention of caries on a large-scale known today.<sup>27</sup> As Dean<sup>17</sup> insists, "fluoridation is a proven, effective, cheap and safe method for the partial control of dental caries."

Fluoridation of communal waters is effective, it is practical, and it works when used on a large scale as a public health measure. These outcomes have been demonstrated conclusively by 10-year scientific studies at Grand Rapids,<sup>46</sup> Newburgh,<sup>48</sup> and Brantford.<sup>49</sup> The weight of evidence seems to indicate quite positively that fluoridation of supplies of water is needed.

12. **OBJECTION:** Fluorine has been outlawed by the United Nations for use in warfare.

**APPRAISAL:** The question of whether fluorine, the elemental gas, can or cannot be used as a war gas has no bearing whatever on its toxicity in traces or in the form of fluorides. The compounds of fluorine, like those of other elements, have specific and characteristic properties of their own.<sup>50</sup>

It is well known that the gaseous chlorine was used in World War I as a weapon. It also is known that chlorine in trace amounts is a common chemical purifier of communal drinking waters.

The St. Louis Health Division<sup>51</sup> has pointed out that it based its recommendation to fluoridate the St. Louis supply of water on conclusive scientific facts, one of which was ensuring a concentration of fluorine at 1.0 p.p.m. Smith<sup>51</sup> has pointed out that no scientific evidence exists that fluoridated supplies of water containing 1.0 p.p.m. will result in damage to the human organism. In this connection, Smith has stated that "it is pertinent to point out and to repeat over and over again that we are recommending the addition of a trace amount of fluorine — one part of fluorine to one million parts of water — not 2-, 3-, or 50 or any other amount. This is the essence of any scientific discussion of fluoridation. . ."

It is obvious that the use of pure fluorine for the purposes of warfare is not relevant to a scientific discussion of the merits of fluorides incorporated for the reduction of caries.

13. **OBJECTION:** It is definitely not the duty of water companies to practice preventive medicine or dentistry.

**APPRAISAL:** The position of water departments or companies in the supply of fluoridated water has been outlined by the Secretary and Chief Executive Officer<sup>52</sup> of the American Water Works Association. The Association adopted a statement of policy in 1949:

"In communities where a strong public demand has developed and the procedure has the full approval of the local medical and dental societies, the local and state health authorities, and others responsible for the communal health, water departments may properly participate in a program of fluoridation of public water supplies. When the proper authorities approve the treatment, it then becomes the function of the water works utility and industry to follow through willingly and intelligently where proper controls are assured."<sup>53</sup>

Jordan,<sup>52</sup> as Secretary of the Association, has clarified even more the professional philosophy

of operators of water-plants by declaring "It will be noted that the Association expresses no professional opinion concerning the merits of fluoridation — but states that it relies upon the opinion of trained physicians and dentists to advise local administrative authorities whenever it appears that fluoridation of a particular water-supply is needed."

While accepting fully its responsibilities for operating fluoridation, the Association has made it abundantly clear that it is neither the responsibility nor the desire of water companies to make decisions which lie properly in the fields of preventive medicine or dentistry.

14. **OBJECTION:** If a municipality can afford to finance fluoridation, the funds for the purpose could be used more advantageously in providing dental care for the indigent children.

**APPRAISAL:** Dental decay is recognized as man's most common disease. Surveys show that by age six at least 80 per cent of children have experienced dental decay and that the process progresses to afflict over 95 per cent of adults.<sup>54,55</sup> Scientifically controlled 10-year studies, conducted under different auspices and under varying conditions, have provided proof that the recommended fluoridation of water at about 1.0 p.p.m. reduces dental cavities in children by as much as two-thirds.<sup>46,47,48,49</sup>

The New York City Health Department, spending about \$1,000,000 per year, has discussed the dental needs of indigent children.<sup>27</sup> This amount provides dental care for only about 40,000 children per year. The average child in the program needs about seven fillings, plus other dental services. In the program of the Department of Health it has been found that over 300,000 out of 1,000,000 elementary school children do not obtain needed dental care. On the basis of economic need, about one-half of these children, 150,000, in the 6 to 14-year age-group would qualify for treatment by the Health Department. This group does not receive the needed care because of the limitation in funds and staff in proportion to the size of the dental problem. Yet fluoridation for 9 cents, or less, per capita, could cut the problem down two-thirds or more and allow the Health Department's program of dental care to be directed at the dental problems which remain.

Dixon<sup>56</sup> has reported that Philadelphia, after evaluating the safety, costs and effectiveness, began to fluoridate its supply of water. The first year's cost was estimated to be 11 cents per person, or 30 cents per family, a cost much less than the smallest filling. Savings from the previous costs of dental care were estimated at over \$1,400,000 per year. Dixon has pointed out that the Philadelphia Department of Public Health had found fluoridation very worthwhile in carrying out its dental program for indigent children.

Dixon has stated further that "Fluoridation of the water would enable the department to double the number of children treated, with the same staff. In other words 13,000 more children would be provided with necessary fillings and extractions."

The same reasoning and facts apply with equal pertinency to other communities. The demonstrated effectiveness of fluoridation shows that cavities may be reduced more completely and at a lesser cost by fluoridation than by complete dependence upon increased programs of dental treatment. At the present time, the high prevalence and incidence of dental caries demands that both fluoridation of water and programs of clinical care are essential.

15. **OBJECTION:** Many persons who have opposed fluoridation have been tricked, ridiculed and suppressed and are afraid to give testimony.

**APPRAISAL:** Lull<sup>8</sup> indicates that, in addition to the opposition of a minority of sincere skeptics, the antifluoridationists include those who take every opportunity to discredit medical science and legitimate public-health progress. These opponents include the anti-vaccinationists, the antivivisectionists, the cultists, and the quacks. They bring all manner of irresponsible charges. Doty<sup>15</sup> states that the irresponsible charges must be sifted carefully to determine their possible logic and common sense. The irresponsibility of many charges lie in the use of tricks of propaganda to inflame the listener emotionally by the use of distasteful names or phrases, to select portions of scientific reports which, when used out of context, appear to support the opposition's viewpoint and to use unsupported charges, insinuations, and even allegations questioning the integrity of responsible and reputable scientists and public officials.<sup>8</sup>

The reaction of the scientific groups has been to ask for evidence to support assertions, objections, or charges. The Health Department of St. Louis, Missouri,<sup>51</sup> has stated: "Before actual fluoridation started (in St. Louis, September, 1955), there was some organized opposition, but this opposition did not have the backing of any recognized scientific group. *They were unable to present any valid evidence against fluoridation.*"

In Milwaukee, Wisconsin, Krumbiegel<sup>57</sup> reported, "The Commissioner of Health has . . . publicly proclaimed his willingness to arrange for the free hospitalization and detailed clinical study of any individual who might allege that his health was being adversely affected by the consumption of fluoridated water. Although this offer was made more than 1 1/2 years ago, no individual has in any way sought to take advantage of this offer."

In Philadelphia, Dixon<sup>56</sup> reported that the City Council arranged a public hearing and

invited opponents and proponents to present their opinions. So overwhelming were the numbers in favor of the project that the City Council enacted the legislation and provided the funds for installing the equipment for the accepted treatment of the water.

The opportunities for antifluoridationists to present tangible evidence in support of their position were not used. An extensive search of the literature fails to reveal data or results of scientifically controlled studies which refute the conclusions of those who recommend fluoridation.

It seems, if the allegation were true, that the attitudes, tactics, and lack of factual data by those who oppose fluoridation may explain their situation. As Maier<sup>58</sup> has said, "Every delay deprives children of a substantial health benefit which may be obtained at a negligible cost."

16. **OBJECTION:** All persons working in departments of health are in a chain of command and must take orders from the officials of the U. S. Public Health Service.

**APPRAISAL:** Knutson<sup>39</sup> has outlined clearly the status and organizational relationships of the U. S. Public Health Service in regard to fluoridation. Knutson mentions (former) Secretary Hobby's letter of Jan. 20, 1954 to the chairman of a Congressional committee. In her letter the Secretary stated that "it is the view of the Department of Health, Education, and Welfare that the decision on whether to fluoridate public water supplies should continue to rest with the local communities."

Knutson<sup>39</sup> stated that the Public Health Service is charged by law to conduct research in health practices, to develop and test measures for the prevention and control of disease, to help states and communities apply these measures and to disseminate information about health-measures. Research on fluoridation was completed and the measure was studied over a long period of time. It was subjected to intensive testing for safety and practicability and its effects were demonstrated, checked and rechecked. Practical methods for its application were worked out and perfected in considerable detail. Then, the facts about fluoridation were made known to state and local health-agencies and technical assistance was provided in the application of fluoridation.

Knutson<sup>39</sup> stated the attitude of the Public Health Service about authoritative chains of command in the following words: "As with all public health procedures, the decision on fluoridation rests and, in our opinion, should continue to rest with the local community. In public health works, it could not be otherwise, nor would we wish it to be otherwise. All local health activities, from the operation of clinics to the enforcement of sanitary regulations, are the responsibilities of the community. We believe there is no justification for any Federal intervention into local health matters.

We feel certain that in fluoridation, as in other health measures, the combination of professional public-health leadership and enlightened citizen-interest will ensure the decision that will enable communities to go forward in health."

There is neither a desire nor a statutory authority for a so-called chain of command by which an "all-powerful" Federal Public Health Service could order fluoridation to be instituted at local levels.<sup>39</sup> The U. S. Public Health Service lacks the constitutional authority to give orders to state and local health agencies as has been stated in this objection.

17. OBJECTION: Proponents of fluoridation may not have considered the effect of cosmic rays on fluoridated water.

APPRAISAL: A search of the scientific literature reveals no reports or studies of any kind relating damaging effects of cosmic rays on fluoridated water.

It seems logical to point out that cosmic rays have been bombarding the earth's surface for centuries. It is apparent that naturally-fluoridated waters undoubtedly have received their share of these rays. Since several millions of people have been drinking such waters for generations in the United States<sup>59</sup> without detectable systemic damage, there appears to be reason to assume that controlled fluoridation would have any different effect. After 10 or more years of study under controlled scientific conditions, the cities using fluoridated water<sup>46,47,48,49,60</sup> have reported significant lowering of rates for dental cavities with no harmful effects whatever on the body.

18. OBJECTION: Fluoridation may foster neglect of oral hygiene.

APPRAISAL: The finding that fluoridation will aid dramatically in reducing the caries-experience of children, and eventually of the adults in a community, does not imply that cleansing of the mouth becomes unimportant.

Smith<sup>61</sup> has pointed out that "Fluoridation does not eliminate tooth decay entirely... fluoridation is not a cure-all; good dental care will continue to be a necessity. Fluoridation is a preventive measure but is not 100 per cent effective. It is no more a substitute for good dental care than pasteurization is a substitute for clean production of milk."

It is true that it has been suggested by Fossdick,<sup>62</sup> from research that has not been repeated in a carefully controlled situation, that conscientious toothbrushing immediately after eating may reduce the incidence of dental decay by approximately 50 per cent. The routine cleansing of the mouth, at any rate, is important to prevent oral disease other than dental caries. The gingival tissues must be kept clean and stimulated if the sequellae of neglect, such as gingivitis and

advanced periodontal disorders, are to be avoided. This same reason for keeping the mouth clean exists after fluoridation as before fluoridation. Therefore, it would appear advisable to include rules for dental hygiene as a routine part of public information when fluoridation of water is being accomplished.

19. OBJECTION: Dentists and physicians must be profiting from fluoridation or they would not promote it.

APPRAISAL: Plato, in his Republic, discussed the professions; he said that each has a special good or service, not primarily concerned with collecting pay.

*Everyone will profit from the beneficial effects of fluoridation.* The people will retain more teeth and enjoy better dental and general health at the cost of a few pennies per year and with the savings of many dollars in dental bills. It has been estimated<sup>27</sup> that fluoridation of drinking water will prevent the decay of over 15 teeth per person at the average cost of \$6.30 for the present life expectancy of 70 years.

Physicians and dentists also will benefit by seeing their patients in better health. Dentists expect to gain more time for phases of dental service which have been postponed or neglected because their time has been consumed by treating the emergencies of carious lesions. As the need for restoring carious teeth decreases, the dentist can turn his attention to the completion of all of the services for supporting tissues and occlusion which his patients should receive. At present, the dentist cannot meet more than a minor part of the treatment required by children.

Fluoridation of public water has been studied by numerous groups under varying conditions, through national and local organizations. It is endorsed by all major national health organizations.<sup>27</sup> Fluoridation provides opportunity for the professions to improve health on a large scale. Fluoridation provides direct health benefits to families while actually saving them money. It is true that *everyone* profits from fluoridation.

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