The Concept of Orthoiodosupplementation and Its Clinical Implications

by Guy E. Abraham, MD

Introduction

The recommended daily allowance (RDA) of elemental iodine by the Food and Nutrition Board of the United States National Academy of Sciences was not established until 1980, and it was not confirmed until 1989.[1]

In that year, 1989, the Executive Director of the International Council for Control of Iodine Deficiency Disorders (that is a very impressive title to say the least), Basil S. Hetzel, published a book entitled *The Story of Iodine Deficiency*.[2] In that book, goiter and cretinism were the only two aspects of iodine deficiency discussed. One would assume that the experts on human requirements for iodine have already figured out the amounts of iodine needed for sufficiency of the human body (i.e., the daily amount of iodine needed for the prevention and control of cretinism and endemic goiter). However, the 1930 statement of Thompson, *et al*,[3] is still valid today: "The normal daily requirement of the body for iodine has never been determined." In the ninth edition of the classic textbook of nutrition, *Modern Nutrition in Health and Disease*, edited by Shils, *et al*, and published in 1999, the section on iodine was written by no less than Basil S. Hetzel and coauthored with Graeme A. Clugston.[4] They reported the latest recommended intakes of iodine established in 1996 by the World Health Organization (WHO), based on age and physiological conditions. The highest recommended daily intakes are for pregnant and lactating women — 200 mcg or 0.2 mg. In a subsection entitled "Iodine toxicity," the authors stated: "Wolff[39] has suggested that human intakes of 2,000 mcg I/day should be regarded as excessive or potentially harmful." Please note, the unit mcg is used instead of 2 mg in order to make the amount appear really "excessive." For example, if they used the unit ng, that amount would be 2,000,000 ng, a number that would scare just about anybody. Reference 39 in this citation was authored in 1969 by the world famous thyroidologist, I. Wolff,[5] coauthor of the world famous Wolff-Chaikoff effect published in 1948.[6] There was a fly in the Wolff-Chaikoff ointment, however.

In 1993, Ghent, *et al*,[7] reported that daily intake of iodine at 0.1 mg/kg BW was effective in fibrocystic disease of the breast. The title of the article — "Iodine replacement in fibrocystic disease of the breast" — implies that this abnormality of the breast was due to iodine deficiency and the amount of iodine used, that is 5 mg/day for a 50 kg woman, was within the physiological ranges of iodine intake. Ghent's study did not confirm Wolff's prediction that daily iodine intake of 2,000 mcg (2 mg) was "excessive and potentially harmful" as quoted by Hetzel and Clugston.[4] Based on academic credentials and reputation, the opinion of thyroidologist Wolff, from the National Institute of Health, would prevail over the findings of Canadian gynecologist Ghent. However, being interested in facts only, not in preconceived opinions of famous thyroidologists, this author initiated an extensive search of the literature on iodine in medicine.

The concept of orthoiodosupplementation is the outcome of this intensive literature search, which started seven years ago, combined with some original clinical research performed by the author. The clinical aspects of this research were performed under contract at the Flechas Family Practice Clinic in Hendersonville, North Carolina under the supervision of Jorge D. Flechas, MD, and funded with grants from Optimox Corporation. The author designed the protocols and monitored the progress and completion of each project. Informed consent was obtained from all the subjects participating in these projects. Pilot studies were performed with tablets containing Lugol solution in amounts per tablet ranging from 1 to 12.5 mg and compounded by John C. Hakala, RPh, from Hakala Apothecary in Lakewood, Colorado. The results of some of these projects have been published,[8-12] with Flechas and Hakala as coauthors in two publications.[10,11]

From a review of the published data, it soon became evident that medical textbooks contain several vital pieces of misinformation about the essential element iodine, which may have caused more human misery and death than both world wars combined.[8,9] The purpose of this manuscript is to present some useful information about iodine and to discuss the concept of orthoiodosupplementation in more detail than in previous publications.[9,11] This manuscript was written in response to a request from the eclectic and altruistic physician, a recent collaborator on the iodine project, David Brownstein, MD, to expand further on the concept of orthoiodosupplementation with more details than in the previous publication[9] in order to help the practicing physician fully appreciate the impact of this concept on their practice. Dr. Brownstein recently wrote a book about his experience with the implementation of orthoiodosupplementation in his practice.[13]

The Various Natural Forms of Iodine

The element iodine exists in nature under several forms:

(Continued on next page)

inorganic sodium and potassium salts of iodates (IO3-) and iodides (I-); inorganic diatomic iodine (I2); and organic monatomic iodine (C-I). The first reported, naturally occurring, halogenated organic compound was 3,5-diiodothyrosine, isolated in 1896 by Drechsel from the coral, *Gorgonia cavolinii*.[14] Surprisingly, invertebrates and algae have the ability to synthesize the "thyroid hormone" thyroxine (T4).[15] Evidence will be presented later for the synthesis of T4 by human leukocytes.

In the US, various forms of iodine have been used in food products: iodides in table salt since the 1920s; iodates in bread from 1960-1980; and diatomic iodine in municipal waters (on an experimental basis only).[9] Since the 1940s, radioisotopes of iodide became available for diagnostic and therapeutic purposes. The most common forms of iodine used in clinical medicine are listed in Table 1. The organic iodine-containing compounds, whether occurring naturally or manmade, have properties distinctly different from inorganic iodine/iodates/iodides.

Table 1

Various Forms of Iodine/Iodide Used in Clinical Medicine[9]

A) Inorganic
1) Non-Radioactive
   a) Iodides (I.e., SSKI)
   b) Tincture of Iodine
   c) Lugol Solution
2) Radioactive Iodides for Diagnostic and Therapeutic Purposes

B) Organic
1) Naturally Occurring
   a) Thyroid hormones
   b) Thyroidal Iodolipids
2) Man-made
   a) Radiographic Contrast Media
   b) Iodine-Containing Drugs (I.e., Amiodarone)

Sources of Iodine in Nature

The greatest reservoir of iodides is in the oceans of our planet, although present in very diluted concentrations (0.05 mcg/ml of sea water); therefore, this is not a good starting material for industrial production of iodine. However, sea algae can concentrate iodides by several orders of magnitude. For example, iodide concentrations as high as 0.5% wet weight have been reported in red algae,[16] a concentration 100,000 times higher than that present in seawater. From the discovery of iodine in 1811 until 1840, France was the sole producer of iodine. Japan did not become a major iodine producer until 1888.[17] Currently, the major iodine producers are the US, Japan, and Chile; caliches, oil wells, and deep well water are the major sources.

The iodine cycle starts and ends in the oceans. Under the influence of sunlight, the iodides in seawater are oxidized to diatomic iodine I2. Due to sublimation at ambient temperature and atmospheric pressure, the I2 gas evaporates in the air in an estimated amount of 400,000 tons per year.[2] This form of diatomic iodine can be absorbed through the lungs by breathing air, which usually contains approximately 1 mcg/m3, a very insignificant source of iodine. The high voltage currents flowing through clouds reduce the diatomic iodine to iodides dissolved in water droplets which fall on the soil in the form of rain. Rivers return the iodide to the oceans to complete the cycle.

Iodine Metabolism in Man

Diatomic iodine (I2) can be absorbed through the lungs and through the skin.[18,19] However, ingested food, drinks and iodine/iodide supplementation, are the most common means of supplying iodine to the human body. Without interfering substances present in the gastrointestinal tract, inorganic iodine, iodates, and iodides are quantitatively absorbed. The elimination of peripheral inorganic iodide occurs almost exclusively through renal clearance.[20] Organic and inorganic iodine are not cleared by the kidneys. When inorganic iodide is ingested in amounts ranging from 0.001 mg up to 2,000 mg, Childs, *et al*,[20] estimated an average renal clearance of serum inorganic iodide of 50L/day over the whole range of intakes. Fisher, *et al*,[21] and Koutras, *et al*,[22] have measured serum inorganic iodide levels at equilibrium in subjects ingesting increasing amounts of iodide from 75-1,250 mcg/day. Their results are displayed in Table 2. When these data are plotted on an X-Y axis (Figure 1), a high degree of correlation (0.999) was obtained with a slope of 0.023. The slope is an index of renal clearance: 1/0.023 = 43.5 L/day.

To compute the serum inorganic iodide levels at equilibrium in a subject ingesting a narrow range of iodine/iodide, divide the average daily intake expressed as milligrams elemental iodine by 43.5 liters to obtain the serum concentration of inorganic iodide expressed as mg/L of serum. Besides giving accurate information about the peripheral concentrations of iodide available for uptake by the cells and organs of the human body, measurement of serum inorganic iodide levels is very useful for assessing bioavailability of the iodine/iodide ingested. Alexander, *et al*,[23] measured the serum inorganic iodide levels in normal subjects consuming an average of 70 mcg iodide per day, but no iodized salt. He observed a mean value of 1.8 mcg/L. This measured value is very close to

(Continued on next page)

the value computed by dividing 70 mcg/day by 43.5 liters/day = 1.6 mcg/L. This is evidence that the iodine present in the food and drink of these subjects is highly bioavailable. Pittman, *et al*,[24] measured serum inorganic iodide levels in two groups of subjects: one group after iodization of salt, with an estimated daily intake of 750 mcg iodide, and the other group after iodization of bread, with a similar average daily intake of iodates.[25] The expected mean serum level at equilibrium would be 17.2 mcg/L (750 mcg/43.5 L). The mean values observed by Pittman, *et al*,[24] were 1.7 mcg/L for subjects after iodization of salt, and 18.7 mcg/L for subjects after iodization of bread. These data suggest that iodate in bread is very bioavailable, whereas only 10% of iodide in iodized salt were absorbed. On a molar basis, there is 30,000 times more chloride than iodide in iodized salt. Chloride competes with iodide for absorption in the intestinal tract.[26] To this author's knowledge, the low bioavailability of iodide in iodized salt has never been reported.

Using ion-selective electrode measurement, following chromatography on anion-exchange resins,[27] serum inorganic iodide levels were measured by the author serially for 24 hours in five normal subjects and one obese man, following a single ingestion of 37.5 mg of iodine/iodide from a tablet form of Lugol solution (three tablets of Iodoral®).[9] Baseline serum iodide levels were below the sensitivity of the assay (0.006 mg/L) in all the subjects tested. There was no significant difference in the levels and pattern of serum levels obtained in three normal women (subjects A, B, C) and two normal men (subjects D and E) (Figure 2). The serum inorganic iodide levels increased rapidly to reach peak levels between 1.4 and 1.8 mg/L at 2-3 hours post ingestion, and decreased afterward. The serum levels were still elevated at 24 hours post ingestion, ranging from 0.3-0.5 mg/L. The serum levels observed in an obese man (subject F) (Figure 2) were much lower and approached baseline by 8 hours post ingestion. Sequestration of iodine by fats may be the explanation for this observation. With selective uptake of iodine, but not iodide by fats, obesity would create a selective iodine deficiency for tissues like the mammary glands possessing a preference for iodine.[28,29] Following ingestion of 50 mg (four tablets) of the same preparation in six normal premenopausal subjects, the serum inorganic iodide levels followed the same profile as the one observed in the five normal subjects following ingestion of 37.5 mg elemental iodine but with higher serum levels. The baseline inorganic iodide levels were below the sensitivity of the assay in all six subjects.

The expected serum inorganic iodide levels at equilibrium for subjects ingesting 50 mg iodine/iodide would be 1.15 mg/L (50 mg/43.5 L). In eight normal subjects (three males and five females) ingesting four tablets of Iodoral® (50 mg) daily for three months, the serum inorganic iodide levels at equilibrium ranged from 0.85-1.34 mg/L with a mean ± SD of 1.1±0.18 mg/L. This finding confirms the high bioavailability of the Lugol tablet (Iodoral®) routinely used in the iodine/iodide loading test and for orthoiodosupplementation.[9]

Thyroidal Metabolism of Iodide

Serum inorganic iodide is in dynamic equilibrium with the exchangeable pool of inorganic iodide in the thyroid gland. This pool was estimated at 6-7 mg iodide by Koutras, *et al*.[22] Uptake of inorganic iodide by the thyroidal Na/I symporter system increases with increased peripheral levels, but only up to a point. The maximum daily thyroidal uptake was estimated at 0.6 mg/day when 50 mg of iodide are ingested daily.[11] Based on studies in farm animals by Marine, saturation of the thyroid occurs with 5 mg iodine per gm (dry wt) of thyroid.[30] That would compute to 50 mg iodine per thyroid gland in an adult man, 8 times the exchangeable pool of iodide. Hyperplastic changes in the

(Continued on next page)

Table 2

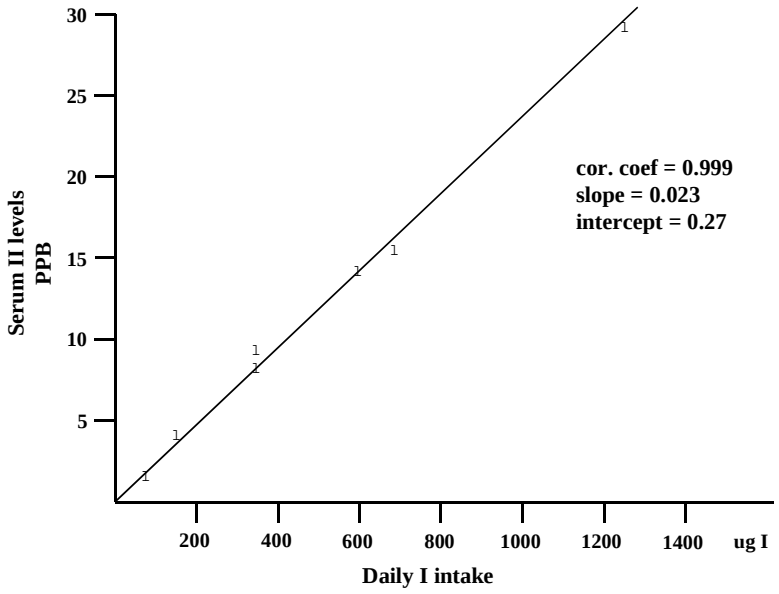
Serum Inorganic Iodide Levels at Equilibrium, Following Increasing Iodine Intake

Average Total I Intake (Diet & Supplement) (mcg/day)	Duration of Intake	Mean Serum II Levels (PPB) (By Isotope Dilution)	References
75	12 weeks	2.1	Koutras, *et al*[22]
150		4.0	
350		8.2	
690		15.5	
350	13 weeks	8.6	Fisher, *et al*[21]
600		14.0	
1250		29.5	

thyroid gland are observed when iodine concentrations drop below 0.1% dry weight (dry wt).[31] Thyroidal concentration of 0.1% iodine corresponds to 1 mg iodine/gm thyroid (dry wt). With an estimated weight of the thyroid gland around 10 gm dry wt in the normal adult, the minimum amount of iodine/iodide in the thyroid before hyperplastic changes occur would be 10 mg (1 mg I/gm x 10 gm). F.M. Delange[32] estimated, from an extensive review of the literature, that daily intake of 0.05 mg iodine and 10-20 mg iodine/thyroid were required to prevent simple goiter. Goiter development correlates better with low thyroidal iodine than with elevated TSH levels, suggesting an autoregulatory role of iodine in the thyroid gland.[33]

Figure 1

Correlation between Intake of Iodide and Serum Inorganic Iodide (II) Levels at Equilibrium.



Elevated TSH induces hypertrophy, whereas intrathyroidal iodine deficiency induced thyroid hyperplasia. In iodine-deficient goiter, iodine supplementation abolishes not only hypertrophy, but also hyperplasia of the thyroid gland. On the other hand, suppression of TSH with T4 abolishes hypertrophy, not hyperplasia if there is intrathyroidal iodine deficiency.[33] Therefore, administration of T4 to iodine-deficient patients does not decrease their risk for thyroid cancer, an effect expected with iodine supplementation.[34] Stubner, *et al*,[33] concluded: "These data indicate that iodine supplementation is the causal therapy for iodine-deficient goiter because it abolishes not only hypertrophy, but also hyperplasia of the glands and restores normal function and regulation." Based on the above findings, orthoiodosupplementation is highly recommended in patients receiving thyroid hormone therapy.

There is an inverse relationship between the iodine concentration of the thyroid gland and total DNA content, indicating an autoregulatory effect of iodine on cell proliferation (anticarcinogenic effect). Recent investigations on this autoregulatory effect of iodine on cell proliferation suggest that it is due to iodinated lipids.[9] Iodination of lipids in thyrocytes requires an amount of iodine/iodide two orders of magnitude greater than the RDA, that is two orders of magnitude greater than required for iodination of thyrosine. Apparently, the thyroid gland requires higher concentrations of iodide in the thyrocyte for the iodination of lipids than for the iodination of thyrosine. For further details on the intrathyroidal metabolism of iodide and synthesis of thyroid hormones, the reader is referred to textbooks of endocrinology and thyroidology where this aspect of iodine metabolism is well described.

Extrathyroidal Metabolism of Iodide

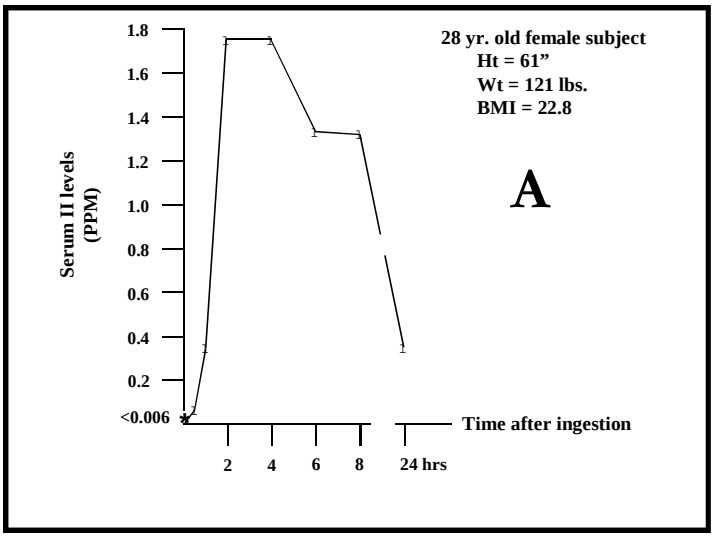
The mammary glands can effectively compete with the thyroid gland for peripheral iodine. Eskin, *et al*,[28] measured the 24-hour radioiodide uptake in 57 clinically normal breasts, and in eight clinically abnormal breasts. The mean ± SD percentage uptake was 6.9±0.46% in the normal breasts and 12.5±1% in abnormal breasts. These means were statistically significant at $p < 0.005$. Considering that these measurements are representative of a single breast, and a woman has two breasts, the percentage uptake per patient is twice these amounts. This brings the 24-hour radioiodide uptake by the mammary glands of a woman in the same range as the 24-hour radioiodide uptake by the thyroid gland. The higher percentage uptake in the abnormal breasts suggests that the abnormal breasts were more deficient in elemental iodine than normal breasts.

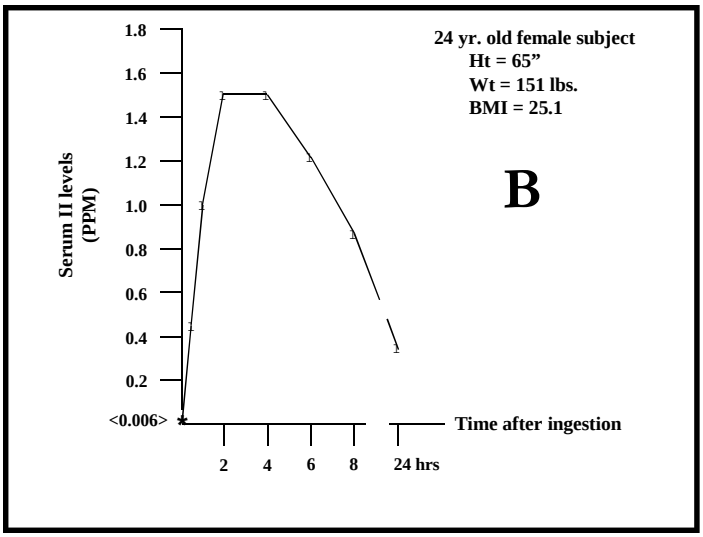
Since the radioiodide uptake study of breast tissue by Eskin, *et al*,[28] was performed with iodide, not iodine, it is likely that the percent uptake by the breast would even be higher if radioiodine were used. There is some evidence that the udder of a lactating cow has a greater need for iodine than the thyroid gland. When the radioisotope 131I was administered to lactating cows under four different chemical forms[35] — diatomic iodine, methyliodine, iodide, and iodate — the average maximum uptake by the thyroid gland was 3.8% of the administered dose, whereas milk from the same cows contained an average of 14% of the administered dose. A slightly higher concentration of radioactivity was observed in the milk of cows fed radioiodine than those fed radioiodide. Of interest are the findings of Eskin, *et al*,[29] that the thyroid gland preferen-

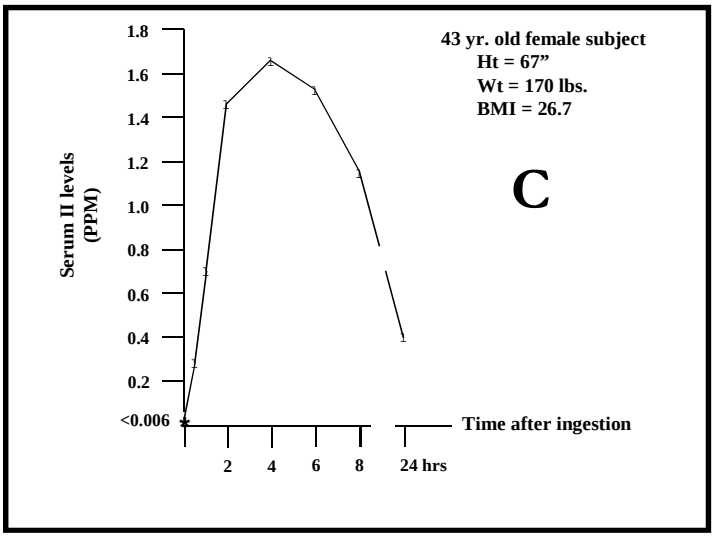
(Continued on next page)

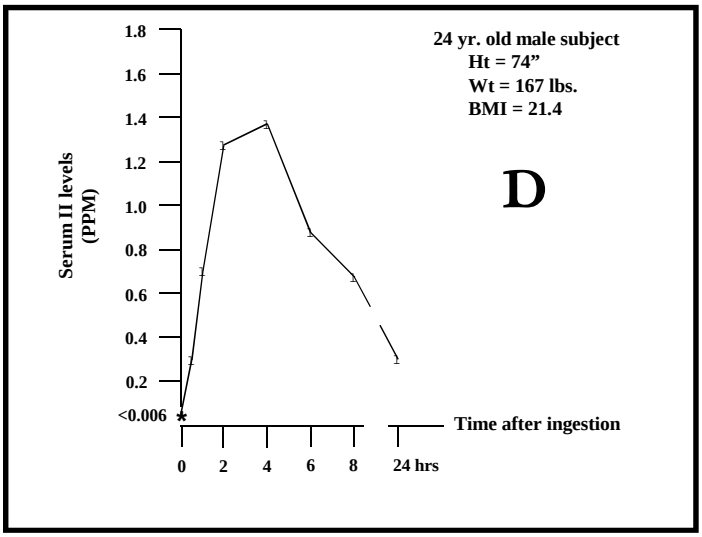
Figure 2

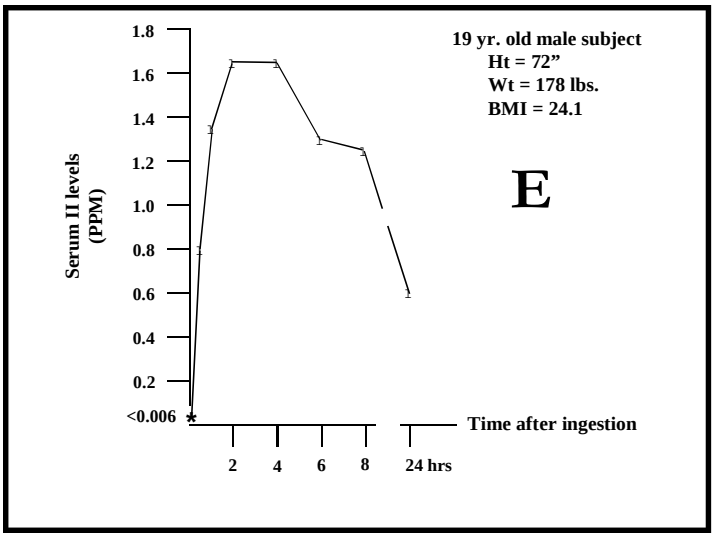
Serum Inorganic Iodide Levels Following Ingestion of Three Tablets of Iodoral®, Containing 37.5 mg Elemental Iodine, in Three Normal Women, Two Normal Men and One Obese Man.

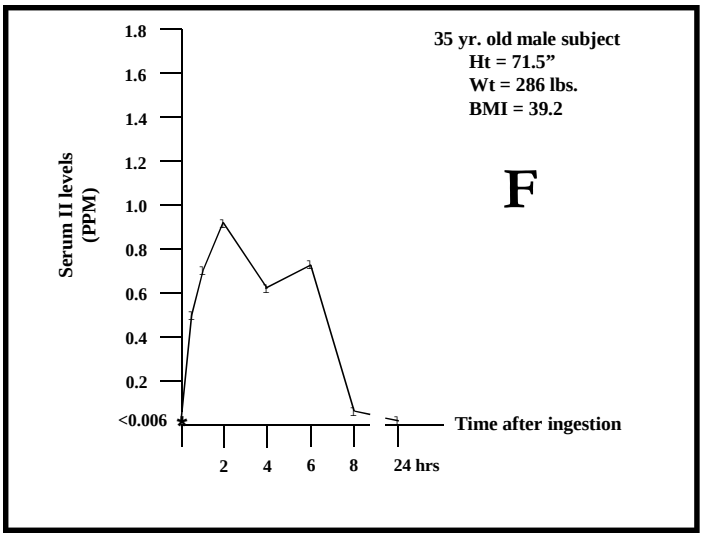












tially concentrates iodide whereas the mammary gland favors iodine. In I-deficient female rats, histological abnormalities of the mammary gland were corrected more completely, and in a larger number of rats treated with iodine, than iodide given orally at equivalent doses. Ghent, *et al*,[7] reported a better response from patients with fibrocystic disease of the breast when inorganic iodine was used, compared with organic iodine and inorganic iodide.

In the rats studied by Thrall and Bull,[36] 20% of the iodide, but not iodine, administered orally was recovered in the skin. This suggests that the skin, like the thyroid gland, has a preference for iodide. Extrathyroidal synthesis of T4 has been demonstrated in thyroidectomized rats by Evans, *et al*,[37] following administration of iodide in amount of 25 mg/kg BW. For a 70-kg human subject, the corresponding amount would be 1.75 g, well within the range of iodides prescribed for pulmonary patients.[9] Iodotherapy in these thyroidectomized rats reversed the effect of hypothyroidism on growth, on the adrenal glands, the ovaries, testicles, and thymus.

Human leukocytes during phagocytosis synthesized T4 when the incubation media contained 10^{-6}M iodide.[38] Extrathyroidal hyperthyroidism with exophthalmia has been reported in patients with leukemia.[39,40] The administration of Lugol solution was effective in these cases.[41,42] Iodine deficiency may play an important role in leukemia. Salivary glands and stomach cells oxidized and organified iodide with the synthesis of iodolipids, mono- and diiodothyrosine, when the incubation media contained 10^{-6}M iodide.[43] The essential element iodine modulates the adrenal response to stress[44] and improves immune functions.[45]

Certain roles of iodine in well-being and protection against infections, degenerative diseases, and cancer may not involve its action on specific organs and tissues. Instead, such properties, affecting every cell in the human body, may depend on iodine/iodide concentrations in biological fluids. Because of its large size, iodine has the ability to markedly enhance the excited singlet to triplet radiationless transition.[46] Szent-Gyorgy was able, 50 years ago, to demonstrate this effect of iodine on the singlet → triplet radiationless transition, at a concentration of 10^{-5}M.[47] To achieve the 10^{-5}M concentration of serum inorganic iodide, a daily ingestion of 50 mg elemental iodine would be required. Reactive oxygen species, causing damage to DNA and other macromolecules, are usually excited singlets with a high energy content released rapidly,[48] and characterized by fluorescence; whereas the corresponding triplet state contains lower energy levels, which are released slowly, expressed as phosphorescence. Singlet-oxygen-induced lesions in DNA are processed by an error-prone repair in mammalian cells. The DNA repair mechanisms are efficient in preserving biological activity but highly mutagenic in mammalian cells.[48] Intake of iodine/iodide at 50 mg/day would decrease the oxidative burden and DNA damage. Such an effect would be anti-carcinogenic in every organ of the human body. A daily intake of 50 mg is also the amount of elemental iodine that saturates the iodide thyroidal symport system[11] and could serve as a preventive measure against unexpected exposure to radioactive iodine/iodide.[9]

An overview of the available data suggests that, for optimal function of the human body, peripheral inorganic iodide levels between 10^{-6}M to 10^{-5}M are required — levels two to three orders of magnitude greater than the level of 10^{-8}M observed in the US population.

The Concept of Orthoiodosupplementation

Orthoiodosupplementation is the daily amount of the essential element iodine required for whole body sufficiency. Whole body sufficiency for iodine is assessed by an iodine/iodide loading test.[9] The iodine/iodide loading test evolved by serendipity from a project to assess the bioavailability of a tablet form of Lugol solution (Iodoral®). From the medical literature, it is stated that urinary iodide levels are the best index of iodine/iodide intake.[2,4] Studies were performed in five normal subjects (two male, three female), with the assumption that urine concentrations of iodide were a reliable index of bioavailability of the product tested.

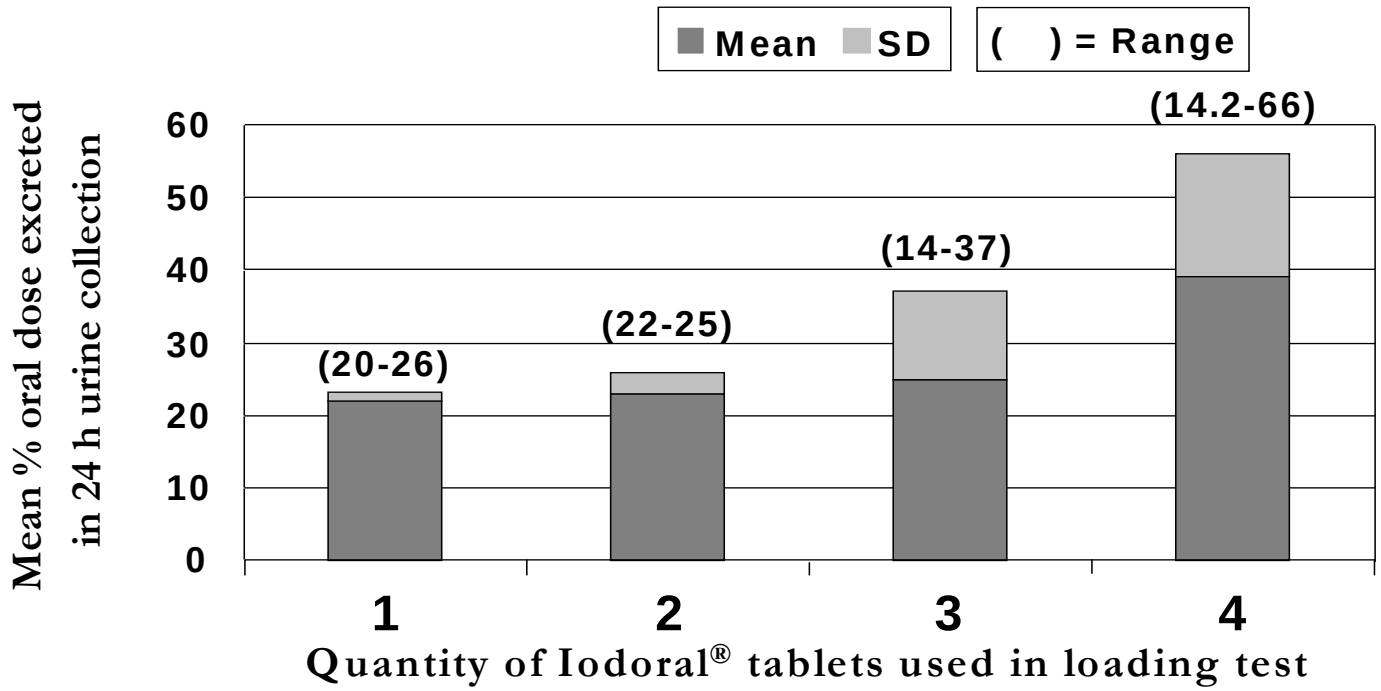
Following oral intake of 12.5 mg Lugol in tablet form, iodide levels in the 24-hour urine collection were measured. The subjects excreted in their 24-hour urine samples only 10-30% of the amount ingested, with a mean of 20%.[27] This low recovery of iodide in the urine samples could be due to either low bioavailability of the product tested or high retention in the body. In order to elucidate the cause of this low iodide excretion, we continued the administration of the supplement in those subjects for one month. Then, we repeated the 24-hour urine collection and iodide was measured again in the 24-hour urine samples. In four of the five subjects, the percentage oral dose excreted in the 24-hour urine sample increased significantly, with a mean group value of 50%.[27] Contrary to medical textbooks, 80% of the iodine/iodide ingested was retained. After one month of supplementation, the body still retained 50% of the ingested amount. The iodine/iodide loading test evolved from these observations. However, instead of a one-month loading test, further studies were performed to shorten this test to a single ingestion of the preparation.

Another group of six subjects, (three male and three fe-

(Continued on next page)

Figure 3

Effect of Increasing Intake of Iodine/Iodide on Percent Urinary Excretion of Ingested Amount[9]



male) were evaluated with 24-hour urinary iodide levels after ingesting one, two, and three tablets of the same preparation. The mean percentage excretions (± SD) were: 22±1.2% for one tablet, 23±2.8% for two tablets, and 25±12.3% for three tablets. In a third group of six subjects, urine iodide levels were evaluated following four tablets of the same preparation. The mean excretion rate was 39±17.2% (Figure 3). For the loading test, a single ingestion of four tablets was chosen because this dose resulted in the highest mean percent iodide excreted and in the widest interindividual variations.

Because of the improved overall well-being reported by the subjects who achieved 90% or more iodide excreted, sufficiency was arbitrarily defined as 90%. Implementation of orthoiodosupplementation, based on the loading test, revealed that sufficiency was not achieved in some subjects even after two years of iodine supplementation at 1-2 tablets/day. To achieve sufficiency within three months, most subjects required 3-4 tablets/day (37.5-50 mg). US physicians over the past century recommended daily intakes between 0.1 ml and 0.3 ml of Lugol solution containing 12.5-37.5 mg elemental iodine.[9] Our medical predecessors were already using orthoiodosupplementation based on their keen observation of their patient's overall well-being. Whole body sufficiency for iodine correlated well with overall well-being, and some subjects could tell when they achieved sufficiency even before knowing the results of the test. Iodine sufficiency was associated with a sense of overall well-being, lifting of a brain fog, feeling warmer in cold environments, increased energy, needing less sleep, achieving more in less time, experiencing regular bowel movements, and improved skin complexion. In some overweight or obese subjects, orthoiodosupplementation resulted in weight loss, decreased percent body fat, and increased muscle mass.

Clinical Implications

The goal of orthoiodosupplementation is not the treatment of disease, but the supply of optimal amounts of an essential nutrient for whole body sufficiency and for optimal mental and physical performance. Whole body iodine deficiency, based on the concept of orthoiodosupplementation, may play an important role in several clinical conditions.

Summary of Findings

Based on the above review of the literature and this author's clinical research studies,[8-12] the concept of orthoiodosupplementation can be summarized as follows:

1) The nutrient iodine is essential for every cell of the human body requiring peripheral concentrations of inorganic iodide ranging from 10^{-6}M to 10^{-5}M.

(Continued on next page)

2) In non-obese subjects, these concentrations can be achieved with daily intake of 12.5-50 mg elemental iodine.

3) The thyroid gland is the most efficient organ of the human body, capable of concentrating iodide by two orders of magnitude to reach 10^{-6}M iodide required for the synthesis of thyroid hormones when peripheral levels of inorganic iodide are in the 10^{-8}M range.

4) Goiter and cretinism are evidence of extremely severe iodine deficiency because the smallest intake of iodine would prevent these conditions, (i.e., 0.05 mg/day) is 1,000 times less than the optimal intake of 50 mg elemental iodine.

5) The thyroid gland has a protective mechanism, limiting the uptake of peripheral iodide to a maximum of 0.6 mg/day when 50 mg or more elemental iodine are ingested. This amount, therefore, would serve as a preventative measure against radioactive fallout.

6) An intake of 50 mg elemental iodine/day would achieve peripheral concentration of iodide at 10^{-5}M, which is the concentration of iodide markedly enhancing the singlet → triplet radiationless transition. This effect would decrease DNA damage with an anticarcinogenic effect.[9,11]

7) Orthoiodosupplementation results in detoxification of the body from the toxic metals, aluminum, cadmium, lead, and mercury.

8) Orthoiodosupplementation increases urinary excretion of fluoride and bromide, decreasing the goitrogenic effects of these halides.

9) Most patients on a daily intake ranging from 12.5-50 mg elemental iodine reported higher energy levels and greater mental clarity with 50 mg (four tablets Iodoral®) daily. The amount of iodine used in patients with fibrocystic disease of the breast by Ghent, *et al*,[7] that is 0.1 mg/kg BW/day, is 10 times below the optimal daily intake of 50 mg. In our experience, patients with this clinical condition responded faster and more completely when ingesting 50 mg iodine/iodide/day.

10) Orthoiodosupplementation may be the safest, simplest, most effective, and least expensive way to solve the health-care crisis crippling our nation.

11) For best results, orthoiodosupplementation should be part of a complete nutritional program, emphasizing magnesium instead of calcium.

12) The iodine/iodide loading test and serum inorganic iodide levels are reliable means of assessing whole body sufficiency for elemental iodine and also for quantifying the bioavailability of the forms of iodine ingested.

Misinformation in Medical Textbooks

The concept of orthoiodosupplementation requires a major revision of commonly held beliefs expounded in medical textbooks regarding iodine metabolism and requirements.

1) Ingested iodine is reduced to iodide in the intestinal tract prior to absorption.

   Ghent, *et al*,[7] and Eskin, *et al*,[29] reported that in women and in female rats, fibrocystic disease of the breast responded better to iodine than iodide. Thrall and Bull[36] observed that in both fasted and fed rats, the thyroid gland and the skin contained significantly more iodine when rats were fed with iodide than with iodine; whereas the stomach walls and stomach contents had a significantly greater level of iodine in iodine-fed rats than iodide-fed animals. Peripheral levels of inorganic iodine were different with different patterns, when rats were fed with these two forms of iodine. The authors concluded: "These data lead us to question the view that iodide and iodine are essentially interchangeable."

2) Urine iodide levels are a reliable index of elemental iodine intake.

   Contrary to the opinions of nutritionists and thyroidologists, urinary excretion of iodide is not a good index of iodine/iodide intake. Besides the low bioavailability of some forms of iodine and iodide, such as sodium iodide in table salt, there is also a significant retention of iodine/iodide by the human body until sufficiency is achieved. Based on our experience with the iodine/iodide loading test, only 10-30% of a highly bioavailable preparation of iodine are recovered in the 24-hour urine collection, when subjects ingested from 12.5-37.5 mg/day. Urinary iodide levels approximate intake only in individuals who achieved iodine sufficiency of the whole body (90% or more of the ingested amount is excreted in the 24-hour urine collection). It is then obvious that urinary iodide excretion is not a reliable index of intake, unless the form of iodine ingested is highly bioavailable and whole body sufficiency is achieved.

3) Absence of goiter and cretinism are evidence of iodine sufficiency.

(Continued on next page)

According to Delange,[32] a daily intake of only 0.05 mg elemental iodine will prevent goiter and cretinism, which are the manifestation of the most severe forms of iodine deficiency. To achieve whole body sufficiency for iodine, 250 to 1,000 times that amount is required.

4) The healthy human adult body contains 15-20 mg of iodine.

Based on calculations derived from the loading test, the retention of iodine by subjects on 50 mg/day for three months ranged from 1,450 to 1,600 mg elemental iodine. This amount was derived by subtracting the amount of iodide excreted from 50 mg prior to and monthly following supplementation. The mean daily amount retained was calculated by averaging. For example, a subject excreted 20 mg iodide/24-hour prior to supplementation and 45 mg after 90 days of supplementation. The amount retained would be:

Day 1 = 50-20 = 30 mg

Day 90 = 50-45 = 5 mg

Daily average = 30 + 5 / 2 = 17.5 mg/day

For 90 days = 17.5 mg/day x 90 days = 1575 mg

The levels of 15-20 mg iodine mentioned in medical textbooks represent severe iodine deficiency based on the concept of orthoiodosupplementation.

5) The thyroid gland contains 70-80% of the total body iodine.

Marine[30] reported that the thyroid gland of farm animals given increasing amounts of iodine contained a maximum of 5 mg iodine per gm thyroid (dry weight). For an adult man, that would compute to 50 mg (5 mg/gm x 10 gm). In an iodine sufficient individual, the percentage of total body iodine present in the thyroid gland would be 3.3% (50 mg/1,500 mg x 100).

6) The normal daily requirement of iodide for an adult is 150-200 mcg (0.15-.2 mg).

If the goal of the International Council for Control of Iodine Deficiency Disorders is to have a world full of sick zombies surviving on antibiotics and toxic drugs, that amount of iodine is more than enough; and the council should not allow more than that amount to be the recommended daily allowance. However, for whole body sufficiency, and for optimal physical and mental health, 100 to 400 times the RDA would be required.

7) The toxic side effects of organic iodine containing drugs are caused by inorganic iodide.

There is a lot of misinformation in the medical literature concerning the safety of the different forms of the element iodine. The inorganic forms are blamed for the severe side effects of the organic iodine-containing drugs.[49] From a publication by Phillippou, *et al*, published in 1992, it is obvious that the cytotoxicity of the organic iodine-containing drugs is due to the molecule itself, not to the iodine released or present in the molecule. "We can, therefore, conclude that the effect of amiodarone, benziodarone, Na iopanate, and other iodine-containing substances with similar effects is due to the entire molecule and not to the iodine liberated. It should be noted that the cytotoxic effect of amiodarone in all cultures is also due to the entire molecule and not to the iodine present in it."[50]

About the Author

Guy E. Abraham, MD, is a former Professor of obstetrics, Gynecology and Endocrinology at the UCLA School of Medicine. Some 35 years ago, he pioneered the development of assays to measure minute quantities of steroid hormones in biological fluids. He has been honored as follows: General Diagnostic Award from the Canadian Association of Clinical Chemists, 1974; the "Medaille d'Honneur" from the University of Liege, Belgium, 1976; the Senior Investigator Award of Pharmacia, Sweden, 1980. The applications of Dr. Abraham's techniques to a variety of female disorders have brought a notable improvement to the understanding and management of these disorders. Twenty-five years ago, Dr. Abraham developed nutritional programs for women with premenstrual tension syndrome and post menopausal osteoporosis. They are now the most commonly used dietary programs by American obstetricians and gynecologists. Dr. Abraham's current research interests include the development of assays for the measurement of iodide and the other halides in biological fluids and their applications to the implementation of orthoiodosupplementation in medical practice.

REFERENCES

1) Food and Nutrition Board, National Academy of Sciences, National

(Continued on next page)

Research Council. *Recommended Dietary Allowances*, 10th edition. National Academy of Sciences Press, Washington, DC, 1989.
2) Hetzel BS. *The Story of Iodine Deficiency. An International Challenge in Nutrition*. Oxford University Press, Oxford, New York, Tokyo, 1989.
3) Thompson WO, *et al*. "The range of effective iodine dosage in exophthalmic goiter." *Arch Int Med*, 1930; 45:261-281.
4) Hetzel BS and Clugston GA. *Iodine. In Modern Nutrition in Health and Disease*, 9th edition. Shils ME, *et al*, editors. Lippincott Williams & Wilkins, 1999; 253-264.
5) Wolff J. "Iodide goiter and the pharmacologic effects of excess iodide." *Am J Med*, 1969; 47:101-124.
6) Wolff J and Chaikoff IL. "Plasma inorganic iodide as a homeostatic regulator of thyroid function." *J Biol Chem*, 1948; 174:555-564.
7) Ghent WR, *et al*. "Iodine replacement in fibrocystic disease of the breast." *Can J Surg*, 1993; 36:453-460.
8) Abraham GE. "The Wolff-Chaikoff effect of increasing iodide intake on the thyroid." *Townsend Letter*, 2003; 245:100-101.
9) Abraham GE. "The safe and effective implementation of orthoiodosupplementation in medical practice." *The Original Internist*, 2004; 11(1):17-36.
10) Abraham GE, *et al*. "Optimum levels of iodine for greatest mental and physical health." *The Original Internist*, 2002; 9(3):5-20.
11) Abraham GE, *et al*. "Orthoiodosupplementation: Iodine sufficiency of the whole human body." *The Original Internist*, 2002; 9(4):30-41.
12) Abraham GE. "Iodine supplementation markedly increases urinary excretion of fluoride and bromide." *Townsend Letter*, 2003; 238:108-109.
13) Brownstein D. *Iodine: Why You Need It, Why You Can't Live Without It.* Medical Alternative Press, West Bloomfield, MI, 2004.
14) Drechsel E. "Contribution to the chemistry of a sea animal." *Z Biol*, 1896; 33:85-107.
15) Hunt S. "Halogenated tyrosine derivatives in invertebrate scleroproteins: Isolation and identification." Chapter 27. In: *Methods of Enzymology*, Volume 107, Postranslational Modifications Part B. Wold F and Moldave K, editors. Academic Press, New York, 1984; 413-438.
16) Fenical W. "Halogenation in the rhodophyta: A review." *J Phycol*, 1975; 11:245-259.
17) Kelly FC. "Iodine in medicine and pharmacy since its discovery — 1811-1961." *Proc R Soc Med*, 1961; 54:831-836.
18) Harrison J. "The fate of radioiodine applied to human skin." *Health Physics*, 1963; 9:993-1000.
19) Miller KL, *et al*. "Effectiveness of skin absorption of tincture of I in blocking radioiodine from the human thyroid gland." *Health Physics*, 1989; 56:911-914.
20) Childs DS, *et al*. "The effect of varying quantities of inorganic iodide (carrier) on the urinary excretion and thyroidal accumulation of radioiodine in exophthalmic goiter." *J Clin Invest*, 1950; 29:726-738.
21) Fisher DA, *et al*. "Effect of increased dietary iodide on thyroid accumulation and secretion in euthyroid Arkansas subjects." *J Clin Endocr*, 1965; 25:1580-1590.
22) Koutras DA, *et al*. "Effect of small iodine supplements on thyroid function in normal individuals." *J Clin Endocr*, 1964; 24:857-862.
23) Alexander WD, *et al*. "Iodine and thyroid function: Physiological significance of the plasma inorganic iodine." *J Clin Endocr*, 1964; 24:851-856.
24) Pittman JA, *et al*. "Changing normal values for thyroidal radioiodine uptake." *NEJM*, 1969; 280:1431-1434.
25) London WT, *et al*. "Bread — A dietary source of large quantities of iodine." *NEJM*, 1965; 273:381.
26) Schiff L, *et al*. "Gastric (and salivary) excretion of radioiodine in man (preliminary report)." *J Nat Can Int*, 1947; 7:349-356.
27) Abraham GE, *et al*. "Measurement of urinary iodide levels by ion-selective electrode: Improved sensitivity and specificity by chromatography on anion-exchange resin." Optimox Research Info #IOD-03. (Reprint available upon request).
28) Eskin BA, *et al*. "Human breast uptake of radioactive iodine." *OB-GYN*, 1974; 44:398-402.
29) Eskin B, *et al*. "Different tissue responses for iodine and iodide in rat thyroid and mammary glands." *Biological Trace Element Research*, 1995; 49:9-19.
30) Marine D and Kimball OP. "Prevention of simple goiter in man." *Arch Intern Med*, 1920; 25:661-672.
31) Underwood EJ. *Trace Elements in Human and Animal Nutrition*. Academic Press, New York, San Francisco, London, 1977.
32) Delange FM. "Iodine deficiency." In: *Werner & Ingbar's The Thyroid.* Braverman LE and Utiger RD, editors. Lippincott Williams & Wilkins, 2000; 295-329.
33) Stubner D, *et al*. "Hypertrophy and hyperplasia during goiter growth and involution in rats - separate bioeffects of TSH and iodine." *Acta Endocr*, 1967; 116:537-548.
34) Gaitan E, Nelson NC, and Poole GV. "Endemic goiter and endemic thyroid disorders." *World J Surg*, 1991; 15:205-215.
35) Bretthauer EW, *et al*. "Milk transfer comparisons of different chemical forms of radioiodine." *Health Physics*, 1972; 22:257-260.
36) Thrall K and Bull RJ. "Differences in the distribution of iodine and iodide in the Sprague-Dawley rat." *Fundamental and Applied Toxicology*, 1990; 15:75-81.
37) Evans ES, *et al*. "Biological evidence for extrathyroidal thyroxine formation." *Endo*, 1966; 78:983-1001.
38) Stole V. "Stimulation of iodoproteins and thyroxine formation in human leukocytes by phagocytosis." *Biochem Biophys Res Commun*, 1971; 45:159-168.
39) Minot GR and Means JH. "The metabolism pulse ration in exophthalmic goiter and in leukemia." *J H Arch Int Med*, 1924; 33:576-580.
40) Friedgood HB. "The relation of the sympathetic nervous system and generalized lymphoid hyperplasia to the pathogenesis of exophthalmic goiter and chronic lymphatic leukemia." *Amer J Med Sci*, 1932; 183:841-849.
41) Friedgood HB. "The effect of Lugol's solution on chronic lymphatic leukemia and its bearing upon the pathogenesis of exophthalmic goiter." *Am J Med Sci*, 1932; 183:515-529.
42) Friedgood HB. "The effect of Lugol's solution on the elevated basal metabolism in conditions other than exophthalmic goiter." *J Clin Invest*, 1931; 10:172.
43) Banerjee RK, *et al*. "Peroxidase-catalysed iodotyrosine formation in dispersed cells of mouse extrathyroidal tissues." *J Endocr*, 1985; 106:159-165.
44) Nolan LA, *et al*. "Chronic iodine deprivation attenuates stress-induced and diurnal variation in corticosterone secretion in female Wistar rats." *J Neuroendocr*, 2000; 12:1149-1159.
45) Marani L, *et al*. "Role of iodine in delayed immune response." *Israel J of Med Sci*, 1985; 21:864.
46) Kasha M. "Collisional perturbation of spin-orbital coupling and the mechanism of fluorescence quenching. A visual demonstration of the perturbation." *The Journal of Chemical Physics*, 1952; 20:71-74.
47) Szent-Gyorgyi A. *Bioenergetics*. Academic Press, NY, 1957; 113.
48) Sies H. "Damage to plasmid DNA by singlet oxygen and its protection." *Mutation Research*, 1993; 299:183-191.
49) Roti E and Vagenakis AG. "Effect of excess iodide: Clinical aspects." In: *Werner and Ingbar's The Thyroid.* Braverman LE and Utiger RD, editors. Lippincott Williams & Wilkins, 2000; 316-329.
50) Phillippou G, Koutras DA, Piperingos G, *et al*. "The effect of iodide on serum thyroid hormone levels in normal persons, in hyperthyroid patients, and in hypothyroid patients on thyroxine replacement." *Clin Endocr*, 1992; 36:573-578. u