# Strategic Choices in Science Translation in Public Health: A Case Study of Iodine, Goiter, and Children in Michigan 1925

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**October 1, 2024**

# I. INTRODUCTORY NOTES

## *Prior Preparation*

- Carefully read the following case study and be familiar with all the appendix material prior to the class session. Your team may allocate appendix material to specialists to spread the work.
- In case studies, rather than being "spoon fed" the most relevant facts and right answers, students are given many facts and need to sift them and decide what is relevant to solve the problem and what is not relevant.
- Students will take the role of the "**decision-maker**". In this case they will be asked to play the role of being the State Health Officer for Michigan in 1925. They will have to make the best choices given what is known. There will be no perfect answers.
- Public health concepts required for this task are listed below and students should do further research on unfamiliar theories or definitions.

| **Public Health** | **Political Economy** |
|---|---|
| Evidence-based interventions | Stakeholder engagement |
| Contextualizing | Political backlash |
| Scaling up | Paternalism |

## *Case Discussion Breakdown*

- Split yourselves into groups of 5.
- Prepare answers to the questions in Section II to share with the class.

## *Case Synopsis*

This case confronts students with the problems faced when science opens the door to the prevention of two scourges: *cretinism* and *goiter*. *Cretinism* is a condition now known to be caused by iodine deficiency before birth that leads to permanent mental impairment. *Goiter* is a syndrome with deficiency of thyroid hormone with fatigue, weight gain, learning difficulties and swelling in the neck known as *goiter*. A century ago, both cretinism and goiter were much more common throughout the world.

Figure 1: Photo of a patient suffering from Cretinism.

Photo Source: G. E. Shuttleworth & W. A. Potts, Public domain, via Wikimedia Commons

Figure 2: Photo of a patient suffering from Goiter.

Photo Source: Wen-Yan King

Public health has deployed many successful strategies to eradicate nutritional deficiency diseases. Goiter and cretinism were the first conditions that public health was able to address. This case goes back to the beginning when science first discovered a pathway to prevention in the 1920s. Public health planners had to figure out how to apply the new science. This case puts you in their shoes.

The issue came to prominence during World War I, when a report by the U.S. War Department found that up to 30% of military recruits from states like Michigan and Minnesota had goiters and were unfit for service. This spurred state health officials to take action. A report was led by a team of scientists led by R.M. Olin [55]. At the same time, research by David Marine and O.P. Kimball in the late 1910s and early 1920s demonstrated that providing iodine drops could effectively prevent endemic goiter in schoolchildren. Exhibit 1A presents the original studies of Olin and of Marine and Kimball.

**"…30% of military recruits from states like Michigan and Minnesota had goiters and were unfit for service."**

However, the varying political stances and historical relationships between the government and citizens in Michigan may have complicated the decision-making process. As a more conservative

state, the Michigan government's approach to public health initiatives and its interactions with citizens could have created challenges or conflicts of interest among different stakeholders. The medical community also has a vested interest in seeing diseases as a problem that should be treated in a clinic using medications that are prescribed by doctors who have made a medical diagnosis. Understanding the nuances of the local political and social context is crucial when examining the successful eradication of cretinism and goiter in the state, as these factors may have influenced the timeline and implementation of the iodine supplementation program.

In 1919, Michigan's State Health Commissioner, R.M. Olin started Michigan's own survey of goiter in school children and found that 47 % had goiter [55]. He invited Marine to address all the State health officers in Lansing in December 1922 and circulated reprints of the talk. Olin also organized a 1922 symposium on thyroid diseases with the Michigan State Medical Society to highlight the problem and brainstorm a solution within the medical community.

Assessment surveys and convening stakeholders are bedrock strategies in public health. Work like this often precedes legislative advocacy. Olin seriously contemplated an end game where these steps would lead to a state mandate requiring all school children to get iodine drops in schools [56]. However, the solution to American iodine deficiency was ultimately achieved in Michigan without a mandate. The US still does not mandate the use of iodine to fortify food items or water. Other countries have used legal mandates. The US remains the largest country in the world that has conquered goiter without mandates. For any solution to a public health problem to work, public health needs strong partners and must avoid losing trust by triggering charges of paternalism[1].

## Learning Objectives

At the end of the case, students should be able to:

- Contextualize a problem to its local health, economic and political context.
- Formulate three solutions to the problem.
- Evaluate the costs and benefits of the solution, as well as its feasibility
- Propose methods to evaluate the effectiveness of the solution.

## Assignment Questions

A. Outline the primary issues of the case.

[1] Paternalism is behavior that is intended to benefit a person but benefits them by constraining their life choices in a non-consultative manner.

B. Formulate and evaluate three possible solutions to this case.
C. Perform a stakeholder analysis.
D. How do GHD concepts interact with this case?

# II. ANALYSIS

## QUESTION 1: PROBLEM IDENTIFICATION

### What is the issue?

You are Michigan's Health Officer in the 1920s, and you've just received an advance copy of Olin's report on the number of officers who suffer from goiters. You have also had a visit from Dr. Marine and Dr. Kimball who share their findings from Akron school children. Read these sources in the Appendix.

What would be the priority issues of concern that can be acted on? Justify your answer.

| |
|---|
| |

### Question 2: Assessment of alternative strategies to apply Marine and Kimball's discoveries to improve health in Michigan.

Propose three alternative strategies to use and evaluate the costs, political challenges, unintended consequences and possible conflicts of interest.

| |
|---|
| **Solution 1:** |
| **Solution 2**: |
| **Solution 3**: |

## QUESTION 3: STAKEHOLDER ANALYSIS

### Stakeholder Identification and Power Assessment

As Michigan's State Health Officer, analyze the stakeholders of this case and identify potential courses of action, with a projected analysis of interests and influences.

| Stakeholder | Interests | Influence/Power | Priority Actions |
|---|---|---|---|
| Consumers (Patients) | | | |
| | | | |
| | | | |
| | | | |
| | | | |

### Strategy for Decision Explanation

Given the stakeholders at hand, choose the best solution to your problem as the State Health Officer, explaining why this is the best course of action despite the costs and benefits this might bring, any predicted repercussions, or conflicts of interest between stakeholders.

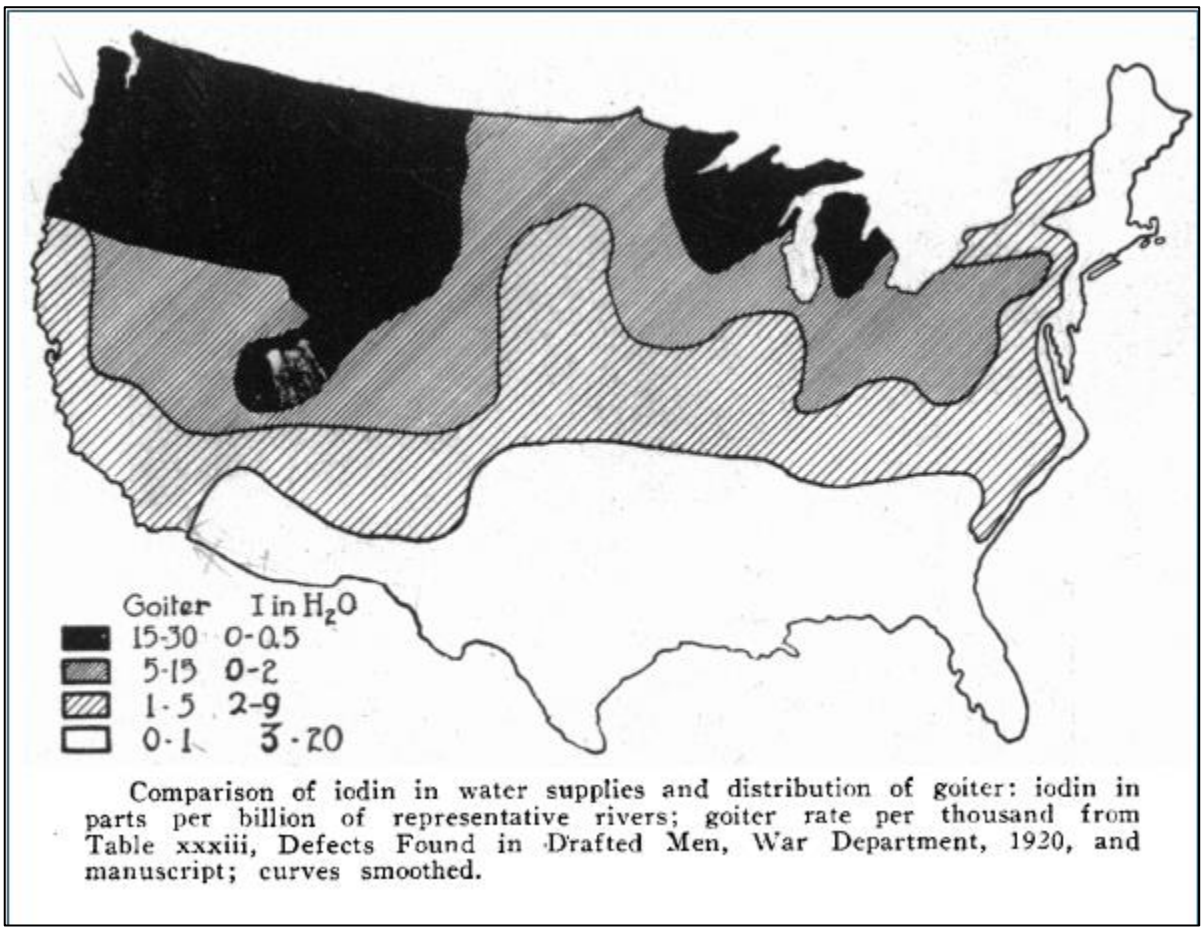
## Question 4: Application of Global Public Health and Development Concepts

Goiters are still a prevailing public health issue in developing countries, such as Ethiopia. Teshome et. al (2024) states that "the overall prevalence of goiter in Gazgibla District, Ethiopia among adolescent girls was 42.5%." Goiter can be easily cured with iodine drops, which costs no more than $20 USD per oz. Why hasn't the disease been eradicated in these communities? What are some barriers to implementing food fortification in developing economies? Use concepts from the field of public health to elaborate on the possible causes of this circumstance.

# III. EXHIBITS

## Exhibit 1: Scientific Background Papers

Exhibit A. Comparison of Iodine Composition in Water and Geographical Distribution of Goiter in the US, 1920




Comparison of iodin in water supplies and distribution of goiter: iodin in parts per billion of representative rivers; goiter rate per thousand from Table xxxiii, Defects Found in Drafted Men, War Department, 1920, and manuscript; curves smoothed.

Historical data has shown a clear correlation between areas with low iodine levels in the soil and water, and the prevalence of cretinism and goiter. In the U.S., the "goiter belt" was centered in the upper Midwest and Great Lakes region, where up to 70% of children had clinically detectable goiters. Similar patterns were observed in Europe, with goiter belts in the Alps, Pyrenees, and the Carpathian Mountain areas.

Exhibit B: Map of 4 Water Bodies surrounding Michigan

Exhibit C: Distribution of Saline, Fresh and Brine Water Sources in Michigan

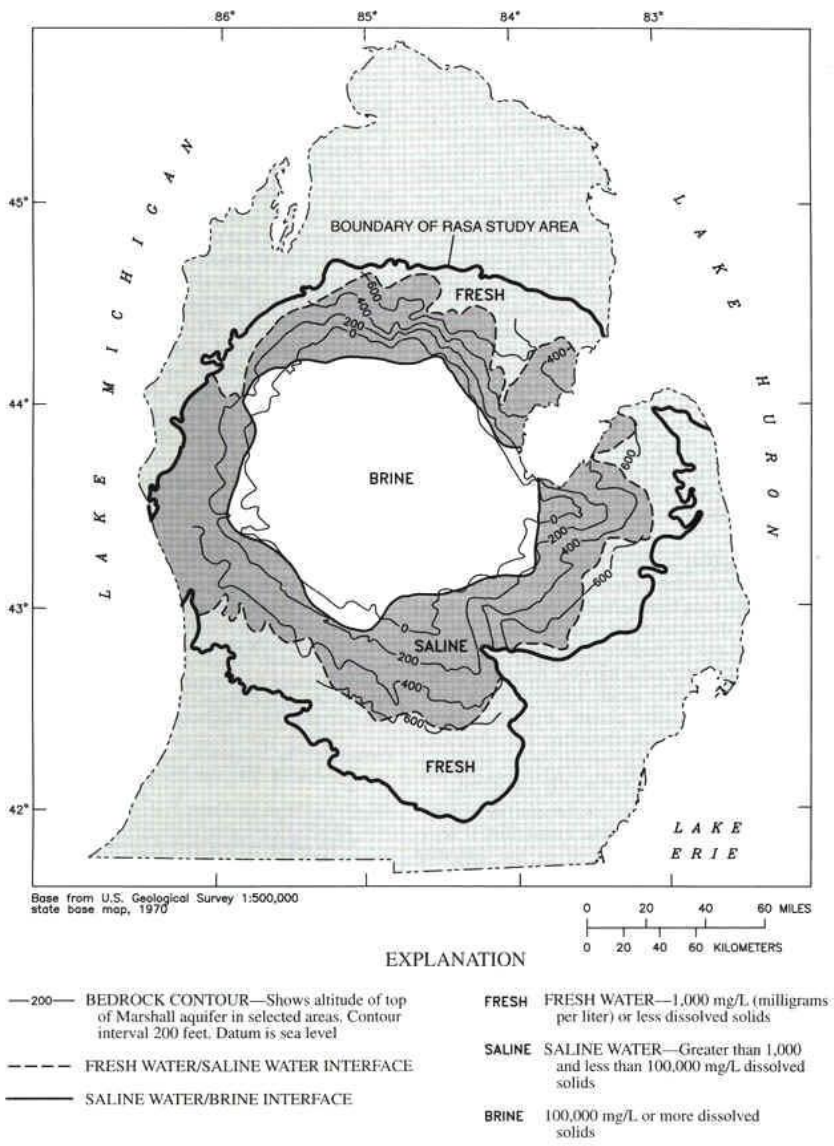



FIGURE 28.—Distribution of freshwater, saline water, and brine in the Marshall aquifer, central Lower Peninsula of Michigan.

## Exhibit 2: Historical Background Papers

Exhibit A: List of Michigan Governors from 1917-1937, with their political leanings indicated.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 29 |  | | **Albert Sleeper** (1862–1934) [121][122] | January 1, 1917[123] – January 1, 1921 (did not run) | Republican[52] | 1916<br>1918 | Luren Dickinson[s] |
| 30 |  | | **Alex J. Groesbeck** (1873–1953) [124][125] | January 1, 1921[126] – January 1, 1927 (did not run) | Republican[52] | 1920<br>1922<br>1924 | Thomas Read<br>George W. Welsh |
| 31 |  | | **Fred W. Green** (1871–1936) [127][128] | January 1, 1927[129] – January 1, 1931 (did not run) | Republican[52] | 1926<br>1928 | Luren Dickinson |
| 32 |  | | **Wilber M. Brucker** (1894–1968) [130][131] | January 1, 1931[132] – January 1, 1933 (lost election) | Republican[52] | 1930 | |
| 33 |  | | **William Comstock** (1877–1949) [133][134] | January 1, 1933[v] – January 1, 1935 (lost nomination)[w] | Democratic[52] | 1932 | Allen E. Stebbins |
| 34 |  | | **Frank Fitzgerald** (1885–1939) | January 1, 1935[138] – January 1, 1937 | Republican[52] | 1934 | Thomas Read |

Exhibit B: Geographic Distribution of Party Leaning by County in Michigan, 1920

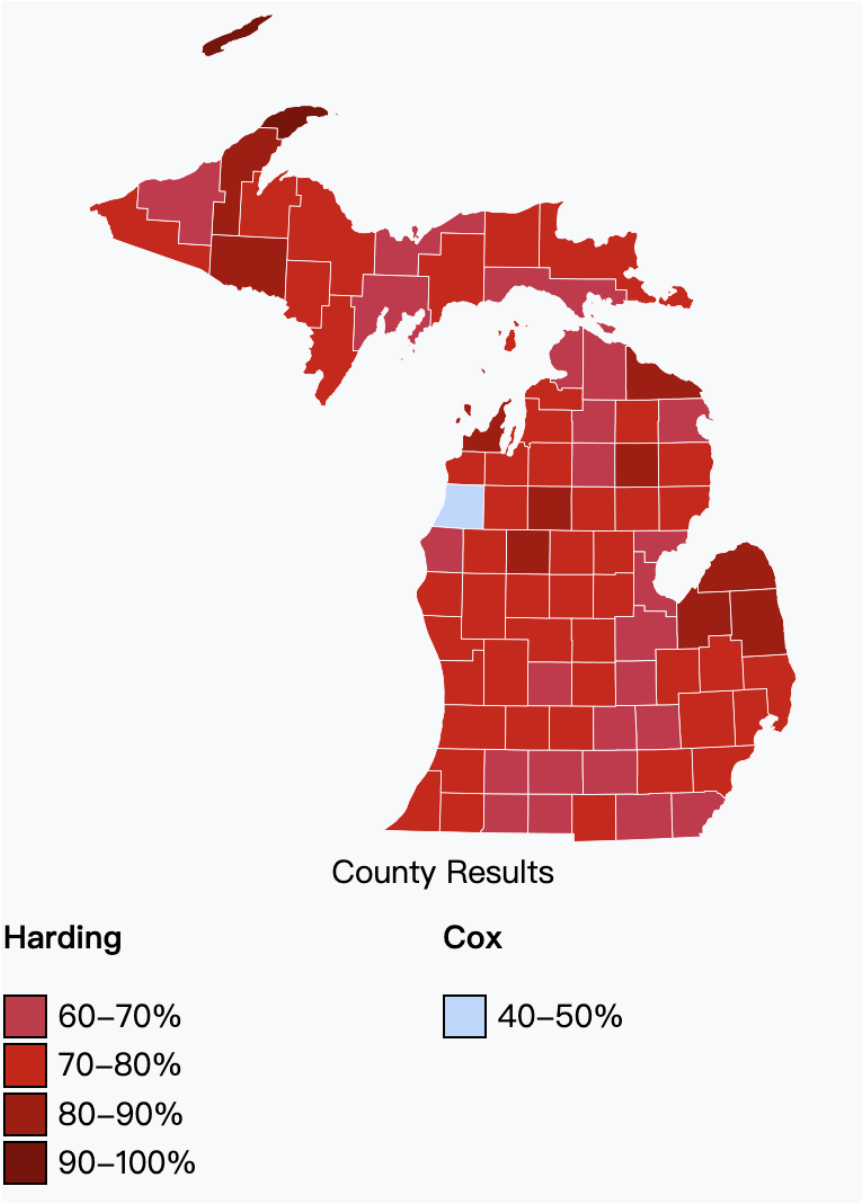


Exhibit C: Population, Net Income and Tax Statistics by States, 1920

*Personal returns, by States and Territories, and per capita distribution, calendar year 1920.*

| States and Territories. | Population, census 1920. | Returns. | | Net income. | | Tax. | |
|---|---|---|---|---|---|---|---|
| | | Number. | Per cent of total. | Amount. | Per cent of total. | Amount. | Per cent of total. |
| Alabama | 2,348,174 | 52,984 | 0.73 | $156,604,933 | 0.66 | $4,482,805 | 0.42 |
| Alaska | 54,899 | 9,899 | .14 | 19,400,775 | .08 | 248,605 | .02 |
| Arizona | 334,162 | 24,812 | .34 | 67,280,486 | .28 | 1,325,905 | .12 |
| Arkansas | 1,752,204 | 38,113 | .53 | 118,060,710 | .50 | 3,268,450 | .30 |
| California | 3,426,861 | 396,973 | 5.47 | 1,329,006,594 | 5.60 | 50,447,505 | 4.69 |
| Colorado | 939,629 | 74,198 | 1.02 | 219,277,184 | .92 | 6,766,900 | .63 |
| Connecticut | 1,380,631 | 148,195 | 2.04 | 451,737,702 | 1.90 | 15,774,598 | 1.47 |
| Delaware | 223,003 | 18,937 | .26 | 55,633,321 | .23 | 2,122,025 | .20 |
| District of Columbia | 437,571 | 69,730 | .96 | 208,388,174 | .88 | 8,536,632 | .79 |
| Florida | 968,470 | 42,210 | .58 | 141,105,124 | .59 | 5,242,705 | .49 |
| Georgia | 2,895,832 | 73,325 | 1.01 | 228,619,716 | .96 | 7,697,693 | .72 |
| Hawaii | 255,912 | 13,715 | .19 | 55,572,896 | .23 | 4,075,539 | .38 |
| Idaho | 431,866 | 25,755 | .35 | 67,391,639 | .28 | 1,086,614 | .10 |
| Illinois | 6,485,280 | 542,467 | 7.47 | 1,836,956,942 | 7.74 | 85,409,203 | 7.93 |
| Indiana | 2,930,390 | 189,587 | 2.61 | 556,061,991 | 2.34 | 15,780,124 | 1.47 |
| Iowa | 2,404,021 | 183,398 | 2.53 | 631,560,789 | 2.66 | 18,776,990 | 1.75 |
| Kansas | 1,769,257 | 99,255 | 1.37 | 306,413,429 | 1.29 | 8,351,303 | .78 |
| Kentucky | 2,416,630 | 78,258 | 1.08 | 243,879,230 | 1.03 | 7,292,098 | .68 |
| Louisiana | 1,798,509 | 69,340 | .96 | 237,109,145 | 1.00 | 9,626,591 | .90 |
| Maine | 768,014 | 47,717 | .66 | 143,455,545 | .60 | 4,892,419 | .46 |
| Maryland | 1,449,661 | 148,000 | 2.04 | 482,195,448 | 2.03 | 21,189,233 | 1.97 |
| Massachusetts | 3,852,356 | 401,770 | 5.53 | 1,368,406,648 | 5.76 | 69,368,994 | 6.45 |
| Michigan | 3,668,412 | 305,075 | 4.20 | 895,679,238 | 3.77 | 40,493,261 | 3.77 |
| Minnesota | 2,387,125 | 154,118 | 2.12 | 453,212,241 | 1.91 | 15,169,869 | 1.41 |
| Mississippi | 1,790,618 | 28,022 | .39 | 83,954,352 | .35 | 2,495,207 | .23 |
| Missouri | 3,404,055 | 162,199 | 2.23 | 548,130,178 | 2.31 | 21,877,701 | 2.03 |
| Montana | 548,889 | 45,557 | .63 | 109,348,194 | .46 | 2,033,190 | .19 |
| Nebraska | 1,296,372 | 97,729 | 1.35 | 306,362,706 | 1.29 | 8,363,305 | .78 |
| Nevada | 77,407 | 10,381 | .14 | 25,337,934 | .11 | 390,077 | .04 |
| New Hampshire | 443,083 | 35,983 | .50 | 100,431,539 | .42 | 2,720,793 | .25 |
| New Jersey | 3,155,900 | 296,989 | 4.08 | 977,853,627 | 4.12 | 43,275,477 | 4.03 |
| New Mexico | 360,350 | 13,656 | .19 | 36,923,120 | .16 | 612,573 | .06 |
| New York | 10,385,227 | 1,047,634 | 14.42 | 4,030,623,696 | 16.99 | 286,607,280 | 26.65 |
| North Carolina | 2,559,123 | 47,342 | .65 | 163,799,837 | .69 | 9,620,675 | .89 |
| North Dakota | 646,872 | 24,209 | .33 | 66,188,434 | .28 | 1,105,801 | .10 |
| Ohio | 5,759,394 | 447,998 | 6.17 | 1,407,388,003 | 5.94 | 56,285,168 | 5.24 |
| Oklahoma | 2,028,283 | 81,785 | 1.13 | 295,790,791 | 1.25 | 13,548,211 | 1.26 |
| Oregon | 783,389 | 67,640 | .93 | 193,652,281 | .82 | 6,649,011 | .62 |
| Pennsylvania | 8,720,017 | 672,746 | 9.27 | 2,212,178,029 | 9.32 | 118,750,989 | 11.05 |
| Rhode Island | 604,397 | 53,128 | .73 | 180,303,990 | .76 | 11,685,163 | 1.09 |
| South Carolina | 1,683,724 | 33,044 | .46 | 109,246,657 | .46 | 3,236,875 | .30 |
| South Dakota | 636,547 | 34,670 | .48 | 103,578,036 | .44 | 2,228,187 | .21 |
| Tennessee | 2,337,885 | 65,054 | .90 | 212,600,105 | .90 | 7,565,009 | .70 |
| Texas | 4,663,228 | 224,617 | 3.09 | 720,720,162 | 3.04 | 25,400,849 | 2.36 |
| Utah | 449,396 | 30,510 | .42 | 82,278,389 | .35 | 1,506,781 | .14 |
| Vermont | 352,428 | 19,205 | .26 | 59,303,302 | .25 | 2,259,129 | .21 |
| Virginia | 2,309,187 | 92,576 | 1.28 | 273,235,229 | 1.15 | 7,404,201 | .69 |
| Washington | 1,356,621 | 148,067 | 2.04 | 375,979,893 | 1.58 | 9,094,764 | .85 |
| West Virginia | 1,463,701 | 96,326 | 1.33 | 287,729,460 | 1.21 | 8,517,268 | .79 |
| Wisconsin | 2,632,067 | 150,452 | 2.07 | 436,436,810 | 1.84 | 13,232,531 | 1.23 |
| Wyoming | 194,402 | 24,594 | .34 | 63,244,529 | .27 | 1,161,320 | .11 |
| Total | 106,021,431 | 7,259,944 | 100.00 | 23,735,629,183 | 100.00 | 1,075,053,686 | 100.00 |

# V. GLOSSARY

## Definition of Key Terms

- Goiter – the irregular growth of the thyroid gland, main causes being lack of iodine in the diet.
- State Mandate - any provision in a State statute or regulation that imposes an enforceable duty on local governments, the private sector, or individuals.
- Democratic Party – one of the leading political parties in the United States, associated with

more progressive policies such as civil rights, progressive taxation, social welfare, and environmental protection.

- Republican Party – another dominant political party in the United States, associated with free market, conservative social policies, reduced taxation, and strong immigration policies.

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# Appendixes

## APPENDIX A. Hirschfelder (1922)



Evidence has been presented by several investigators[15] to show that the water soluble vitamin in certain vegetables is not destroyed by the ordinary household method of boiling the vegetables for from thirty to sixty minutes, but that from 35 to 70 per cent. of the vitamin may be lost in the boiling water. The soluble mineral constituents of vegetables are likewise extracted in variable amounts in the boiling process.[5] It is to be presumed that large amounts of these water soluble constituents are removed by thrice boiling; consequently, small amounts of fresh fruits and vegetables containing mineral salts and accessory substances should be included in a diet depending largely on thrice boiled vegetables for bulk and variety.

The flavor of thrice boiled vegetables may be improved by the use of suitable seasonings, and by the combination of several vegetables into salads or other dishes. From the purely medical standpoint, this factor of palatability and variety in the diet should not be overlooked, since the success of the dietetic treatment of diabetes depends largely on the willingness and ability of the patient to keep within the food limits set by the physician.

Two dietaries for severe diabetics are shown to illustrate the variety such addition of vegetables gives to the diet, and to show the practical value of knowing the carbohydrate content of vegetables used. The values for carbohydrate in thrice boiled vegetables are taken from Table 1, which is a compilation of available data on thrice boiled vegetables. The figures selected are generally the highest values recorded, since some of the lowest values were obtained by using very large amounts of water in boiling, larger than might be practicable in the household. Obviously, if complete extraction of the carbohydrate is accomplished by having sufficient water, a larger amount of vegetable may be used in the diet. Values for other constituents were taken from Locke.[16]

## Clinical Notes, Suggestions, and New Instruments

### A SIMPLE METHOD FOR ADMINISTRATION OF IODIDS IN THE FOOD IN GOITROUS REGIONS *

ARTHUR D. HIRSCHFELDER, M.D., MINNEAPOLIS

Simple goiter is endemic throughout those parts of the United States which are not close to the eastern or western seaboard. It is most prevalent in those regions which are poorest in iodin. The literature on this subject and the distribution of goiter in this country have been reviewed recently by McClendon[1] and by Hayhurst.[2] David Marine[3] has demonstrated conclusively that the development of endemic simple goiter is closely associated with lack of iodin in the food, and that its occurrence can be prevented by the routine administration of iodids.

Marine administered 2.0 gm. of sodium iodid in ten 0.2 gm. daily doses twice a year to more than 2,000 schoolchildren in Akron, Ohio, and found that after this treatment, new enlargements of the thyroid never developed, and, on the other hand, that 38 per cent. of the thyroids which were already enlarged decreased in size.

In the goitrous regions of Switzerland a similar campaign has been carried out during recent years, by various methods of administration, the most satisfactory of which is the giving of iodids in chocolate bonbons once a week. As little as 0.15 gm. of iodids given in the course of a year sufficed to prevent the development of goiter, according to Bayard,[4] Baumann[5] and Klinger.[6]

#### METHOD OF ADMINISTRATION

Since the lack of iodids is really a food deficiency, in certain respects similar to a lack of vitamins, it would appear that the simplest and, certainly, the easiest method is to supply this deficiency along with the food itself, particularly since Plummer[7] has demonstrated that the body requires only minute quantities amounting to about 1 mg. of iodin a day.

The most convenient method for the administration of small quantities of iodid continuously over a long period of time is to add it to the table salt. This does not alter the taste of the salt in the least, and therefore does not carry with it the opprobrium of a "medicine" to the patient; moreover, the easier the method of administration of such a substance the greater the probability of its extended use.

A simple method for household use is this: A stock of sodium chlorid to which 1 per cent. of potassium iodid has been added, "iodized salt," is kept on hand and is sprinkled over the ordinary table salt with an ordinary salt shaker.

This may be used either for iodizing all the salt used both for cooking and at the table, or for the salt used at the table only. In the latter case, on the assumption that from one fourth to one third of the salt ingested is used from the table shakers, the table salt should contain four times as much iodid for each pound as the salt which is used for both cooking and table purposes.

#### DIRECTIONS FOR ORDINARY USE IN ALL THE SALT USED FOR COOKING AND TABLE SALT

The contents of a 5-pound bag of salt are spread on a flat tray or clean table in a thin layer. A salt shaker is emptied. Five teaspoonfuls of the iodized salt is poured into it. The lid of the shaker is put on, and the iodized salt is sprinkled evenly over all parts of the salt spread out on the tray until all the salt in the shaker is used. The salt that has been sprinkled is put into a big bowl, stirred with a spoon to mix thoroughly, and kept for all the uses of the family. This will furnish just as much iodin as the body requires.

To use in table shakers only when iodized salt is not put into the cooking salt, the same thing is done as for the cooking salt, but 2 tablespoonfuls of iodized salt is used to sprinkle over each pound (two large cupfuls) of common salt used, or half a tumblerful for a 5-pound sack, and then this quantity of the iodized salt is sprinkled over the ordinary salt.

The stock of "1 per cent. iodized salt" may be prepared by a pharmacist, or an intelligent housewife may purchase the 10 per cent. potassium iodid solution and prepare it herself.

#### PREPARATION OF THE STOCK "IODIZED SALT" CONTAINING ONE PER CENT. POTASSIUM IODID

A pound of ordinary salt is spread out in a large evaporating dish or enamel pan, and 50 c.c. of a 10 per cent. solution of potassium iodid in 60 per cent. alcohol is slowly sprinkled diffusely over it, from a pipet, or, still better, sprayed on from an atomizer spray, so as to be distributed as evenly as possible over the salt. It is then stirred well with a spoon, dried by evaporation over a water bath, and ground up in a mortar or crushed to a powder with a large spoon.

If the stock of 1 per cent. iodized salt is prepared in the home, it can be dried by leaving the pan on the top of the oven until the salt is about dry, and then heating gently over

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a small flame until perfect dryness is attained. It is then crushed to a powder.

CONCLUSION

The use of the method described will facilitate the prophylaxis of simple goiter and, occasionally, the therapy of very early cases.

## A CASE OF BRAIN ABSCESS OF UNUSUAL ETIOLOGY *

SAMUEL SILBERT, M.D., NEW YORK

Brain abscess usually results from one of three causes: (1) chronic purulent otitis media; (2) fracture of the skull, with or without external injury, and (3) abscesses of metastatic origin. The occurrence in civil life of a brain abscess resulting from direct introduction into the brain of an infected foreign body is sufficiently unusual to warrant publication. Furthermore, had the possible serious sequelae of the injury in this case been borne in mind, the presence of an abscess might have been suspected, and the child's life saved by a timely operation.

REPORT OF CASE

*History.*—A boy, aged 6 years, who had always been in good health, had stumbled and fallen, six weeks before admission, on a stick which he was carrying, causing a small wound on the left side of the face which bled profusely. This wound became infected and discharged considerable pus, but healed firmly in about eight days. The boy then seemed perfectly well and was taken to the country. Four weeks before admission, the child began to complain of headache and seemed a little feverish from time to time. He was taken to a physician, who considered it a gastro-intestinal case and prescribed cathartics and enemas. The headaches continued in spite of the treatment, but the child did not complain of feeling ill and played with the other children. Three days before admission, the headache became so severe and the fever so high, that the boy was put to bed. He did not vomit and had no convulsions. His condition became rapidly worse; he became delirious, and was brought into the hospital in a moribund state.

*Physical Examination.*—The boy was very sick with high fever and delirium. He muttered about severe headache and was very restless, with the head retracted and marked opisthotonos. The eyes showed no ptosis or palsies. The right pupil was larger than the left; both reacted sluggishly to light. There was marked stiffness of the neck. The lungs showed dulness, bronchial breathing and crepitant râles over the left upper lobe. There was a marked bilateral Kernig sign, and the deep reflexes were exaggerated.

*Course.*—The admission diagnosis was pneumonia, with pneumococcus meningitis. A lumbar puncture was made; 25 c.c. of purulent fluid under moderately increased pressure was removed and 20 c.c. of antimeningococcus serum given. A gram-positive diplococcus was reported in the fluid. The condition of the child became rapidly worse, and he died about half an hour after admission to the hospital.

*Necropsy.*—There was a small wound about 1 cm. in length and firmly healed on the left side of the face midway between the outer angle of the orbit and the external auditory meatus. On removal of the skull cap and reflection of the dura, the surface of the brain was found to be covered with thick purulent exudate. The left temporal lobe showed marked flattening of the gyri, and, on palpation, fluctuation was obtained. Section through this area revealed a large abscess cavity filled with thick purulent material. The dura overlying the abscess had a perforation less than 1 cm. in diameter, and a probe introduced into this opening led directly through a similar perforation in the squamous portion of the temporal bone to an abscess under the temporal muscle. The perforation through the bone was the site of a localized osteomyelitis, and from the tract two wooden splinters were recovered. The subtemporal abscess lay directly beneath the healed wound on the left side of the face. Microscopic examination revealed a dense purulent infiltration of the meninges. The organism was a staphylococcus.

Both pleural cavities contained about 100 c.c. of straw-colored fluid. The lungs were voluminous, and, on section, showed marked edema and congestion. No gross abnormality was found in the heart. The liver and kidneys showed marked passive congestion. The spleen was somewhat enlarged, and there was moderate increase in pulp tissue.

The anatomic diagnosis was acute purulent meningitis, brain abscess (left temporal lobe) and acute bronchopneumonia.

COMMENT

It is interesting to note that in spite of the presence of an abscess underlying the wound, complete healing took place. Had the diagnosis of brain abscess been made while the condition of the child was good, the healed wound would have exactly indicated the point for surgical approach. Drainage at this point could have been easily accomplished and complete recovery might have taken place.

35 East Eighty-Fourth Street.

* From the Pathological Department, Mount Sinai Hospital.

## New and Nonofficial Remedies

THE FOLLOWING ADDITIONAL ARTICLES HAVE BEEN ACCEPTED AS CONFORMING TO THE RULES OF THE COUNCIL ON PHARMACY AND CHEMISTRY OF THE AMERICAN MEDICAL ASSOCIATION FOR ADMISSION TO NEW AND NONOFFICIAL REMEDIES. A COPY OF THE RULES ON WHICH THE COUNCIL BASES ITS ACTION WILL BE SENT ON APPLICATION. W. A. PUCKNER, SECRETARY.

**HAY FEVER TIMOTHY POLLEN EXTRACT-MULFORD.**—A liquid obtained by extracting the proteins from the pollen of timothy (*Phleum pratense*) and standardizing the solution by estimating the amount of protein contained in it: 1 unit equals 0.00016 Mg. of pollen protein. Preserved with 0.5 per cent. phenol.

*Actions and Uses.*—See article on Pollen and Epidermal Extract Preparations and Biologically Reactive Food Proteins, N. N. R., 1922, p. 232.

*Dosage.*—See general article on Pollen and Epidermal Extract Preparations and Biologically Reactive Food Proteins, N. N. R., 1922, p. 232.

Manufactured by the H. K. Mulford Company, Philadelphia. No U. S. patent or trademark.

*Hay Fever Timothy Pollen Extract-Mulford.*—Marketed in sets of four syringes containing, respectively, 0.0025 Mg. (15 units), 0.005 Mg. (30 units), 0.01 Mg. (60 units) and 0.02 Mg. (125 units) of pollen protein; in single syringe packages, one syringe containing 0.02 Mg. (125 units), one syringe containing 0.04 Mg. (250 units), one syringe containing 0.08 Mg. (500 units) and one intradermal syringe containing 0.0016 Mg. (10 units) of pollen protein; also in single vial packages, one 5 Cc. vial and one 20 Cc. vial, each cubic centimeter containing 0.02 Mg. (125 units), and one 5 Cc. vial containing 0.04 Mg. (250 units) of pollen protein.

*Series A:* one intradermal syringe containing 0.0016 Mg. (10 units), and five consecutive doses (1-5 inclusive) containing, respectively, 0.002 Mg. (12.5 units), 0.004 Mg. (25 units), 0.008 Mg. (50 units), 0.012 Mg. (75 units) and 0.016 Mg. (100 units).

*Series B:* one intradermal syringe containing 0.0016 Mg. (10 units) and five consecutive doses (6-10 inclusive) containing, respectively, 0.020 Mg. (125 units), 0.024 Mg. (150 units), 0.028 Mg. (175 units), 0.032 Mg. (200 units) and 0.036 Mg. (225 units).

*Series C:* one intradermal syringe containing 0.0016 Mg. (10 units) and five consecutive doses (11-15 inclusive), each dose containing 0.040 Mg. (250 units).

*Complete Series:* the three intradermal syringes and the fifteen consecutive doses described in Series A, B and C.

The pollen, after being dried, is ground in a ball mill to destroy the cell membranes. It is then extracted with physiological solution of sodium chloride. This extract is dried and finally extracted again with physiological solution of sodium chloride. The soluble proteins being brought into solution, a nitrogen determination is made on this extract, and the preparation is then standardized according to the protein (nitrogen) content.

**DIPHTHERIA ANTITOXIN, CONCENTRATED** (See New and Nonofficial Remedies, 1922, p. 280).

E. R. Squibb and Sons, New York.

*Purified Diphtheria Antitoxin (Antidiphtheric Globulin).*—Marketed in syringe containers of 1,000 units (immunizing dose), and in syringe containers of, respectively, 3,000, 5,000, 10,000 and 20,000 units (curative doses).

**NORMAL HORSE SERUM** (See New and Nonofficial Remedies, 1922, p. 278).

E. R. Squibb and Sons, New York.

*Normal Horse Serum.*—(See New and Nonofficial Remedies, 1922, p. 279). Also marketed in packages of one 10 cubic centimeter syringe.

APPENDIX B. Marine and Kimball (2021)

# THE PREVENTION OF SIMPLE GOITER IN MAN*

DAVID MARINE, M.D.
NEW YORK
AND
O. P. KIMBALL, M.D.
CLEVELAND

Simple or endemic goiter is one of the most benign and insidious diseases of man and animals. The sum total of its ravages throughout all ages and in all lands is still unrealized by the public generally, notwithstanding the numerous reports of commissions appointed for its study. Those who live on the sea coasts fortunately have had no need to be concerned; and those who lived in goiter districts—before the days of extensive travel—grew accustomed to look on goiter as natural and normal. Indeed, in many districts of the world, it is still looked on as a mark of beauty.

Simple goiter includes all those thyroid enlargements in man and animals formerly grouped as endemic, epidemic, sporadic and physiologic. It must be sharply distinguished from exophthalmic goiter, with which it has no necessary association or etiologic relationship. Exophthalmic goiter, so far as is yet definitely known, occurs spontaneously only in man, while simple goiter occurs in all animals having the ductless thyroid. Exophthalmic goiter is not notably associated with districts, while with simple goiter this is most characteristic. Exophthalmic goiter occurs more frequently in the highly developed and civilized races, while in simple goiter race is not a factor. Simple goiter may develop sporadically in any place (even at sea, as reported on one of Captain Cook's voyages), but it is preeminently

* From the Laboratories of Western Reserve University, Cleveland, and Montefiore Hospital, New York.
* Read before the Section on Pharmacology and Therapeutics at the Seventy-Second Annual Session of the American Medical Association, Boston, June, 1921.
* This investigation has been made with the assistance of a grant from the Committee on Therapeutic Research, Council on Pharmacy and Chemistry, American Medical Association.

associated with certain regions or districts. The distribution of these districts of endemic goiter throughout the world was fully described by Hirsch, in 1860. The actual incidence of goiter within a given district is still quite unknown. With the information at present available, however, one can distinguish between mildly and severely goitrous districts. As compared with certain other districts, for example, the Alps and the Himalaya regions, our most important districts, namely, the Great Lakes Basin and the Cascade Mountain regions of Oregon, Washington and British Columbia, would be classified as mildly goitrous. The mildness or severity of a district may be determined by the incidence of myxedema or cretinism—a fact known to Morel and expressed in his famous dictum, "Goiter is the first halting place on the road to cretinism" (Le goitre est la première étape sur le chemin qui conduit au cretinisme).

ETIOLOGY

The ultimate cause of simple goiter is totally unknown, notwithstanding a relatively large amount of study. The immediate cause is a lack of iodin. The enlargement, therefore, is a symptom and may result from any factor which increases the iodin needs of the organism, as in certain types of infection, or which interferes wtih the normal utilization of iodin; or it may result from actual experimental deprivation of iodin. The conception that it is due to a contagium vivum in the sense that this term is ordinarily used may be abandoned. Water has been associated as an etiologic factor by all peoples as far back as history goes. The American Indians (Barton) and the natives of Central Africa (Livingston) seem to have been as strongly convinced of the relation of water to the disease as was Hippocrates. If water is a factor, it would seem that it is the absence rather than the presence of some substance, which is to be considered, since goiter is associated with the purest of waters, chemically and bacteriologically as, for example, in Portland, Ore., and in Seattle and Tacoma, Wash., where there has been a rapid increase in goiter since these cities began to take their water supplies from the Cascade Mountains. After consideration of all the various substances, agents and theories that have been put forward as having a rôle

in the etiology of goiter, we at present must fall back on the view that thyroid hyperplasia (goiter) is a compensatory reaction arising in the course of a metabolic disturbance and immediately depending on a relative or an absolute deficiency of iodin.

## PATHOLOGIC ANATOMY

Anatomically, a wide range of changes may be present, depending on the species of animal and on the stage (duration) of the disease. It always begins with a decrease in the colloid material and a hypertrophy of the epithelial cells, at first cuboidal, later columnar, with infoldings and plications. In man and fowls, the stage most commonly observed is characterized by an abundance of colloid material—the so-called cystic or colloid goiter of the older writers—while in dogs, sheep, cattle, pigs, fish, etc., the accumulation of colloid is seen only in the late regressive or quiescent stages. In man, the adenomatous form (struma nodosa) is very common, but it is exceedingly rare in all the lower animals. These adenomas, in all probability, arise from fetal cell rests. The stimulus which initiates the growth of the cell rests (adenomas) and that which initiates the growth of the more differentiated thyroid tissue are probably identical. These growths have many of the attributes of tumor, in that their growth may not be arrested by iodin administration or by the natural physiologic compensation.

## EXPERIMENTAL PHYSIOLOGY

No accomplishment in preventive medicine has a firmer physiologic and chemical foundation than that underlying goiter prevention, and, as the work of prevention is based on certain of these facts, the more important may be reviewed:

1. The active principle of the thyroid is a very stable organic compound of iodin, first recognized by Baumann, in 1895, and recently (1916) isolated in crystalline form, by Kendall.

2. The developmental stage of all goiters is characterized by an increased blood flow, an increase in the size and number of epithelial cells, a decrease in the stainable colloid, and a marked absolute decrease in the iodin store. The decrease in the iodin store precedes the cellular hypertrophy and hyperplasia.

3. Similar changes (compensatory hyperplasia) invariably occur in the remaining portion of the gland, when a sufficient portion of the entire gland is removed. The amount of gland it is necessary to remove in order to cause compensatory hyperplasia varies somewhat with the species of animal, definitely, with the age, diet, and the presence or absence of iodin.

4. The administration of exceedingly small amounts of any salt of iodin in any manner completely protects the remaining thyroid against compensatory hyperplasia, even after the removal of three fourths of the normal gland in cats, dogs, rabbits, rats and fowls. Halsted and Hunnicutt reported a series of partial removals in dogs in which they failed to obtain compensatory hyperplasia, while Loeb has recently reported a series of partial removals in guinea-pigs in which iodin failed to prevent the compensatory hyperplasia, although desiccated thyroid still protected. He concluded that regeneration was physiologically different from spontaneous hyperplasia or simple goiter. The explanation for Halsted's results was probably that the animals were in contact with a source of iodin, while the most probable explanation for Loeb's results is that he removed too much thyroid, since, as shown by Marine and Lenhart, in 1909, iodin will not protect even in dogs if more than three fourths of the gland is removed, while desiccated thyroid will protect the animal against thyroid regeneration even after the removal of as much as nine tenths.

5. If most of the thyroid gland is removed before or in the early stages of pregnancy, and rigid precautions are taken to exclude iodin, the young at birth will have enlarged thyroids, as first shown by Halsted in dogs; while, if iodin is available, the young at birth will have normal thyroids.

6. A milligram of iodin, given at weekly intervals, has been found sufficient to prevent thyroid hyperplasia in pups.

7. Thyroid tissue has an extraordinary affinity for iodin, as has been demonstrated in in vitro perfusions of surviving thyroids, and also by injecting intravenously small amounts of some soluble salt of iodin into the intact animal.

8. If the iodin store in the thyroid is maintained above 0.1 per cent., no hyperplastic changes, and therefore no goiter, can develop.

The foregoing experimental data seem to us sufficiently complete to demonstrate the underlying principles of goiter prevention, and the ease with which they may be applied. The first instance in which these facts were utilized in the prevention of goiter on a large scale occurred in 1909 and 1910. Working with endemic goiter in brook trout, Marine and Lenhart were able to demonstrate that iodin added to the water in a concentration not exceeding 1 : 1,000,000 arrested or prevented the development of thyroid hyperplasia (goiter). Since then, the method has been successfully applied on a large scale by several observers in the prevention of goiter in cattle, sheep, pigs and poultry.

To our knowledge, the prevention of human goiter was not attempted on any large or practical scale until 1917, when we began work with the school population of the city of Akron, although in Cleveland it had been strongly urged and had been used by some physicians for several years. Briefly, the method as applied to man consisted in the administration of 2 gm. of sodium iodid in 0.2 gm. doses, distributed over a period of two weeks, and repeated each autumn and spring. This amount of iodin is excessive, and far beyond the needs of the individual or of the ability of the thyroid to utilize and store it. One gram distributed over a longer period would be better. The form or mode of administration of iodin is of little consequence. The important thing is that iodin for thyroid effects should be given in exceedingly small amounts, and it is believed that most of the untoward effects recorded are due to the excessive doses employed, or, more concretely, to the abuse of iodin.

The results of our two and one-half years' observations on schoolgirls in Akron are as follows: Of 2,190 pupils taking 2 gm. of sodium iodid twice yearly, only five have developed enlargement of the thyroid; while of 2,305 pupils not taking the prophylactic, 495 have developed thyroid enlargement. Of 1,182 pupils with thyroid enlargement at the first examination who took the prophylactic, 773 thyroids have decreased in size; while of 1,048 pupils with thyroid

enlargement at the first examination who did not take the prophylactic, 145 thyroids have decreased in size. These figures demonstrate in a striking manner both the preventive and the curative effects. Klinger has recently (1921) reported even more striking curative results in the schoolchildren of the Zürich district. He worked with school populations in which the incidence of goiter varied from 82 to 95 per cent., while our maximum incidence in Akron was 56 per cent. With such a high natural incidence of goiter, his observations necessarily deal more with the curative effects. Thus of 760 children, 90 per cent. were goitrous at the first examination. After fifteen months' treatment with from 10 to 15 mg. of iodin weekly, only 28.3 per cent. were goitrous, of a total of 643 children reexamined.

The foregoing results were obtained in adolescents. There are two other periods in life when simple goiter frequently develops, namely, (1)) in fetal life and (2) during pregnancy. While the thyroid enlargements developing around the age of puberty are more common, they are not more important than those developing during pregnancy and fetal life. The higher birth mortality of infants with congenital goiter is well known. The thyroid enlargement of both mother and fetus may be prevented by giving 2 gm. of sodium iodid, or its equivalent in iodin in any other form, during the first half of pregnancy.

## UNTOWARD EFFECTS

The dangers of giving iodin, in the amounts indicated, to children and adolescents are negligible. Exophthalmic goiter and iodism are the two important conditions to be looked for. No case of exophthalmic goiter developed in the series reported by Klinger or by us, although in both instances such cases were carefully looked for. Much has been written of iodin-exophthalmic goiters, but a study of the case reports reveals the fact that they resulted from the use of excessive (according to physiologic standards) amounts of iodin, or of desiccated thyroid. In adults, the possibility of aggravating a mild exophthalmic goiter or even the production of the syndrome in susceptible individuals must be considered. Again, the risk is slight. Iodin should not be given in any frank case ot exophthalmic goiter

unless the patient can be daily observed, and then it should be administered only in milligram doses. Iodism was observed in eleven cases among the schoolchildren of Akron during the two and one-half years of observation. Most of these cases were very mild, and the girls did not stop the treatment. Klinger did not observe a single instance in sixteen months' observation on more than 1,000 children, although iodism was carefully looked for.

SUMMARY

Simple or endemic goiter in man may be prevented as cheaply and as simply as in the lower animals, by the administration of 3 to 5 mg. of iodin twice weekly, over a period of a month, and repeated twice yearly. Klinger in Switzerland has reported as striking, and nearly as extensive, results as those obtained by us in Akron. In young individuals, with goiter of recent development, the curative effects of exceedingly small amounts of iodin are as marked as one sees in the goiter of animals.

There are no dangers worthy of consideration associated with the administration of the quantities of iodin used by Klinger or by us. Simple or endemic goiter most commonly develops during (1) fetal life, (2) around the age of puberty, and (3) during pregnancy, and we believe that any plan which provides for its control during these three periods of life will practically eliminate endemic goiter. Goiter in the mother and fetus can be prevented as simply as that of adolescence, but, practically, it would seem that it is a responsibility of individual physicians, supplemented by public education. The prevention of goiter of childhood and adolescence should be a public health measure, best administered through the schools in order to combine the important additional factor of education. Beginning with the period of puberty, goiter occurs approximately six times as frequently in females as in males. The question, therefore, whether general prophylaxis should include both males and females would depend to some extent on whether the particular district was mildly or severely goitrous; hence the need for accurate surveys. The age of beginning and stopping the use of iodin would depend to some extent on race and climate. In the United States, probably the maximum

of prevention coupled with the minimum of effort would be obtained by giving iodin between the ages of 11 and 17 years.

The prevention of goiter means vastly more than eliminating cervical deformities. It means, in addition, the prevention of those forms of physical and mental degeneration, such as cretinism, mutism and idiocy, which are dependent on thyroid insufficiency. Further, it would prevent the development of thyroid adenomas, which are an integral and essential part of endemic goiter in man, and due to the same stimulus. These multiple, circumscribed benign growths have many of the attributes of tumor, one of which is that their growth once initiated is frequently not controlled by iodin, as are all simple hyperplasias. The terminal metamorphoses are far more serious than those of simple hyperplasia, since, in addition to hemorrhage, necroses, cyst formation, etc., probably 90 per cent. of the malignant tumors of the thyroid arise from these adenomas.

If the prevention of goiter is good preventive medicine, it is better preventive surgery. With so simple, so rational and so cheap a means of prevention at our command, this human scourge, which has taken its toll in misery, suffering and death throughout all ages, can and should be controlled, if not eliminated.

*Reprinted from The Journal of the American Medical Association*
*Oct. 1, 1921, Vol. 77, pp. 1068-1070*

APPENDIX C. Olin (1924)



of gangrene was noticeable. Both lids of the left eye were swollen. There was a bloody nasal discharge.

A black gangrenous mass was seen on the first inspection of the nose; this was the nasal septum. A large oval perforation of the cartilaginous septum could be made out. The septum was freely movable, being attached posteriorly and free on three sides. There was a large amount of bloody, purulent material in the floor of the nose. The left inferior and middle turbinates were covered with fibrinous exudate.

The mucous membranes of the mouth were pale and anemic. There was no ulceration of the mucous membranes of the palate. The tonsils were small and submerged, with very little cryptic exudate. Some bloody discharge appeared on the pharyngeal wall. On postnasal examination, a black gangrenous mass was seen filling the left posterior choana. The posterior view of the septum showed it to be gangrenous with the exception of a very narrow strip on the very extremity.

The child was in coma for ten days. She was given 20 units of insulin-Lilly daily, with marked improvement in the general symptoms. The swelling of the eyelids disappeared. Under frequent irrigation, the nose was kept free from discharge. The odor was decidedly that of gangrene at all times. Large sequestrums separated from time to time and were removed.

At present, six months after the onset of the gangrene, the child plays and runs about, and weighs more than she ever has before, but is on a carefully regulated diet with insulin.

Microscopic examination of sections from the decalcified tissue showed in some places a bony structure of normal appearance. In others, there was loss of normal striations, and the bone had a homogeneous appearance. In the marrow spaces, the tissue was necrotic and structureless or infiltrated by many polymorphonuclear leukocytes. No mucosa was present. The pathologic diagnosis was acute osteomyelitis and necrosis of the septum.

There was a large perforation through the septum, which was practically deficient except a narrow border anteriorly and a very narrow strip posteriorly. The posterior extremity was dusky and gangrenous in a portion, and it is questionable whether it will not eventually be lost. In Figure 3 can be seen some of the perpendicular plate of the ethmoid almost to the cribriform plate. Below, the septum has necrosed to the palatal process of the superior maxilla.

### COMMENT

The patients in this series were young children, the oldest being only 10 years of age. The blood Wassermann reaction was negative in two cases of the group, and the case in which no Wassermann test was made there was a negative family history; the child was the eldest of four children, and it is reasonably certain that this child was not syphilitic. This was in the case of gangrene of the cheek, which is less suggestive of syphilis than the other two.

The common type of diabetic gangrene is that occurring in the lower extremity in elderly subjects, with advanced arteriosclerotic changes. In the cases just reviewed, the gangrene developed in children with young vessels, and obviously cannot be explained on an arteriosclerotic basis. Rather, I believe we should consider them a thrombosis of the type described as thrombo-angiitis obliterans; that in the presence of an infection an inflammatory condition resulted in the artery, which was followed by thrombosis and gangrene of the tissue distal to the thrombosed artery.

The discovery of insulin before the last case was treated is responsible for its favorable outcome, as contrasted with that of the two earlier cases.

1136 West Sixth Street.

**Medical Cookery.**—The University of Paris has opened an institute of alimentary hygiene where medical science will be applied to cooking. Instructors from the Pasteur Institute will lecture, although the work is largely practical.

## IODIN DEFICIENCY AND PREVALENCE OF SIMPLE GOITER IN MICHIGAN

### PRELIMINARY REPORT

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Commissioner, Michigan Department of Health
LANSING

That the state of Michigan has an abnormally high percentage of persons affected with goiter has been a matter of common knowledge for years, but of no great concern either to the public or to the medical profession. It was not until 1918 that the matter was given any serious consideration. The selective service regulations brought out the fact that northern Michigan and Wisconsin had a real public health problem to solve. Goiter was so prevalent that in some groups as high as 30 per cent. of the persons were incapacitated for army service, owing to disqualifying toxic goiters.[1] About this time our attention was focused on the work of Kimball and Marine in Ohio, the compilation of reports of whose work at Akron and Cleveland and other localities has been published.[2]

In the fall of 1919, instruction was given to all the traveling representatives of the Michigan Department of Health to collect information wherever possible as to the prevalence of goiter in various sections of the state. This personnel included the traveling tuberculosis clinic, medical inspectors, public health nurses and field workers from the laboratory. Reports coming to the commissioner's office indicated that it would be quite impossible to institute a state wide campaign for the administering of iodin without preparing the field with well organized, educational propaganda. The medical profession had thought little about the relation of iodin deficiency to simple goiter, and the public simply accepted the conditions as an environmental malady for which there was no relief. With the publication of Levin's second paper [3] in 1921, which showed that of 1,783 persons in Lake Linden, Mich., 1,146 had thyroid enlargement, the first local seed was sown for a goiter campaign. This lead was immediately followed up in January, 1922, when the department representatives, Dr. Thomas Marsden and Miss Romani, R.N., made a survey of Iron Mountain, Mich., which demonstrated that 54 per cent. of the persons examined had perceptible thyroid enlargements. Table 1 gives the distribution according to maternal nativity.

The publication of these facts in the state press, and the dissemination of the information by the bureau of education of the Michigan Department of Health through their lecturers, stimulated, in 1922, some interest in the cause and prevention of simple goiter. Accordingly, to foster this awakening and to get first-hand information as to the methods of procedure in use in Ohio by Marine and Kimball, Dr. Marine [4] was called from Montefiore Hospital, New York, to deliver an address before the annual conference of health officers of the state of Michigan, which was held at Lansing in December, 1922. An abstract of his talk was reprinted, and the state was circularized.

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2. Marine, David; Lenhart, C. H.; Kimball, O. P., and Rogoff, J. M.: Prevention of Simple Goiter, Bull. Western Reserve Univ. **26**, July, 1923.
3. Levin, Simon: One Thousand One Hundred and Forty-Six Goiters in One Thousand Seven Hundred and Eighty-Three Persons, Arch. Int. Med. **27**: 421 (April) 1921.
4. Marine, David: The Prevention of Goiter, Public Health, Mich. Dept. of Health **11**: 23 (Jan.) 1923.

Shortly after the public health conference in 1922, Dr. C. C. Slemons, health officer of Grand Rapids, instituted a survey in that city.[5] Twenty-six thousand children returned 30 per cent. positive perceptible thyroid enlargements. With the completion of the Grand Rapids survey and its publication, the department was constantly receiving inquiries from all sections of the state as to the prevalence and means of prevention of goiter in their section. The two surveys in northern Michigan, one by Levin and one by the department, compared with the Grand Rapids survey, showed a very great difference in the number of individuals affected. Consequently, in conference with the advisory council of health, I decided to institute a careful survey of representative areas, so that some scientific data as to the prevalence of goiter in any given community could be determined with relative accuracy.

TABLE 1.—*Distribution of Goiter at Iron Mountain, Mich., According to Maternal Nativity*

| Mothers | Total No. | Enlarged Thyroid No. | Enlarged Thyroid % | Degree 1 No. | Degree 1 % | Degree 2 No. | Degree 2 % | Degree 3 No. | Degree 3 % |
|---|---|---|---|---|---|---|---|---|---|
| Native | 176 | 105 | 60 | 75 | 71 | 21 | 20 | 9 | 8 |
| Norwegian and Swedish | 92 | 51 | 55 | 42 | 82 | 8 | 25 | 1 | 1 |
| Canadian | 34 | 18 | 52 | 13 | 72 | 3 | 16 | 2 | 11 |
| Italian | 158 | 66 | 41 | 54 | 81 | 11 | 16 | 1 | 2 |
| English | 25 | 10 | 40 | 8 | 80 | 2 | 20 | 0 | 0 |
| Austrian | 48 | 22 | 45 | 18 | 81 | 4 | 18 | 0 | 0 |
| Finnish | 18 | 5 | 27 | 5 | 10 | 0 | 0 | 0 | 0 |
| Russian and Polish | 6 | 1 | 16 | 1 | 100 | 0 | 0 | 0 | 0 |
| German | 6 | 4 | 66 | 3 | 75 | 0 | 0 | 1 | 25 |
| French, Belgian and Dutch | 6 | 4 | 66 | 3 | 75 | 1 | 25 | 0 | 0 |
| Total | 569 | 286 | 50.2 | | | | | | |

| Children of | Total No. | Enlarged Thyroid No. | Enlarged Thyroid % | Degree 1 No. | Degree 1 % | Degree 2 No. | Degree 2 % | Degree 3 No. | Degree 3 % |
|---|---|---|---|---|---|---|---|---|---|
| Native mothers | 683 | 361 | 52 | 321 | 88 | 35 | 9 | 5 | 1 |
| Norwegian and Swedish mothers | 446 | 271 | 61 | 215 | 79 | 49 | 18 | 7 | 2 |
| Canadian mothers | 178 | 90 | 51 | 82 | 88 | 6 | 6 | 3 | 3 |
| Italian mothers | 798 | 435 | 54 | 351 | 80 | 61 | 18 | 3 | 1 |
| English mothers | 126 | 67 | 49 | 59 | 86 | 9 | 13 | 0 | 0 |
| Austrian mothers | 242 | 132 | 54 | 112 | 84 | 18 | 13 | 2 | 1 |
| Finnish mothers | 73 | 39 | 53 | 31 | 79 | 7 | 17 | 1 | 2 |
| Russian and Polish mothers | 30 | 18 | 60 | 11 | 61 | 5 | 27 | 2 | 11 |
| German mothers | 35 | 15 | 42 | 15 | 100 | 0 | 0 | 0 | 0 |
| French, Belgian and Dutch mothers | 21 | 15 | 48 | 14 | 93 | 1 | 6 | 0 | 0 |
| Total | 2,652 | 1,445 | 54.49 | | | | | | |

McClendon,[6] after examining 100 specimens of water from various sections of the United States and tabulating the various goiter surveys that had been made, stated that it was his belief that the amount of simple goiter in the United States varied inversely with the amount of available iodin in the food supply of the areas. His data were so meager and the areas of the country covered so large that it was decided to choose the areas in Michigan to be surveyed for goiter only after a preliminary water survey for iodin content had been made.

### IODIN SURVEY

Fifty samples of water were collected, of 15 gallons each, from localities representing the whole area of Michigan. The methods of analysis and final survey for the iodin content of waters in Michigan will be reported elsewhere. From this preliminary survey, four counties were chosen as showing the greatest differences in iodin content and representative of a cross-section of the population of Michigan. Six samples of water were collected in each county and an analysis made, with results as shown in Table 2.

### FIELD SURVEY

As previously stated, the counties selected for this survey were chosen after a study of iodin content of the ground waters, and their location is shown on the map (Fig. 1).

It will be observed that Houghton County is in the northwestern part of the Upper Peninsula, and is partially surrounded by the waters of Lake Superior. Wexford County is in the northwestern part of the Lower Peninsula, and inland from the Great Lakes. Macomb County is about midway of the southern half of the Lower Peninsula on the extreme east side, and is partially bordered by the waters of Lake St. Clair, whereas Midland County is in about the east central part of the Lower Peninsula, and is inland from the Great Lakes.

Consultation with Drs. W. J. Robinson and R. A. Smith of the Michigan State Geological Survey indicated that there is a fundamental geological consideration involved. A subsequent report will show an analysis of the geology of these areas and the iodin content of the water supply.

Taking advantage of the presence of Dr. O. P. Kimball [7] of Cleveland, who was in Lansing to address the conference of health officers and public health nurses, the field medical staff of the department, consisting of four clinicians and two medical inspectors, met with Dr. Kimball and made an examination of about 400 children in one of the schools of Lansing, and the staff was thoroughly drilled in the methods of classification used by Dr. Kimball. Dr. Kimball's classification included only visible enlargements of the thyroid. Visible, simple goiters and adenomas were divided into three classes, 1, 2 and 3, depending on the extent of the enlargement. Exophthalmic goiters were to be considered separately. None were found in the survey. The form of examination card used is shown in Figure 2.

TABLE 2.—*Differences in Iodin Content of Water*

Iodin Content, Parts per Billion

| Macomb | | Midland | | Wexford | | Houghton | |
|---|---|---|---|---|---|---|---|
| Mount Clemens | 28.0 | Midland | 18.0 | Cadillac | 2.4 | Houghton | None |
| Mount Clemens | 20.0 | Midland | 12.0 | Cadillac | 0.8 | Houghton | |
| Mount Clemens Spring | 2.0 | Midland | 11.6 | Mesick | None | Springs | None |
| Romeo | None | Midland | 0.7 | Harrietta | None | Dozlle Agricul- | |
| Richmond | 0.3 | Coleman | Trace | Manton | None | tural School | None |
| Utica | 1.0 | Sanford | 1.4 | Harlan | None | Calumet | None |
| | | | | | | Chassel | None |
| | | | | | | Hubbell | None |
| | | | | | | Lake Linden | None |
| | | | | | | South Range | None |
| Average | 8.7 | | 7.3 | | 0.5 | | None |

An experienced organizer visited the county ahead of the survey staff and made arrangements for transportation and for the schedule of examinations in the schools. The cards were placed in the teachers' hands and were completely filled out in advance of the survey—an important administrative detail. When the

5. Reed, Torrance; and Clay, H. T.: A Survey of Thyroid Enlargement Among the School Children of Grand Rapids, Public Health, Mich. Dept. of Health **11**: 287 (Aug.) 1923.

6. McClendon, J. F.: Simple Goiter as a Result of Iodin Deficiency, Preliminary Paper, Method of Determining Iodin, J. A. M. A. **80**: 660 (March 3) 1923; Iodin and Prevention of Goiter, Science **56**: 269, 1922.

7. Kimball, O. P.: Endemic Goiter as a Public Health Problem, Public Health, Mich. Dept. of Health **12**: 59 (Feb.) 1923.

examining staff reached a school, each child was ready with his own card in his hand. The nurse took the card from the child and entered the result of the examination by making a circle around the letter or number, "N" (normal), "1," "2" or "3," as the case might be. Each medical officer was accompanied by a nurse, who did all the preparatory work and kept the records, each school being kept by itself.

Fig. 1.—Counties in which children were examined.

These cards were sent each day to Lansing, and a tabulation sheet was made, showing the results for each school. These, in turn, were compiled to show the results for each county. The compilation sheet is reproduced in Figure 3.

In Macomb County there were 10,258 examined, of whom 2,672 were found with goiter, or 26 per cent. Of the 5,152 boys examined, 79.9 per cent. were normal and 20.1 per cent. showed goiter. Of the 5,106 girls examined, 68 per cent. were normal and 32 per cent. showed goiter.

In Midland County there were 3,645 examined, of whom 1,191 showed goiter, or 32.7 per cent. There were 1,834 boys examined, of whom 75.6 per cent. were normal and 24.4 per cent. showed goiter. Of the 1,811 girls examined, 58.9 per cent. were normal and 41.1 per cent. showed goiter.

The total number examined in Wexford County was 3,984, of whom 2,216 showed goiter, or 55.6 per cent. Of these, 1,963 were boys, and of this number we found 52.4 per cent. normal and 47.6 per cent showed goiter. Of the 2,021 girls examined, 36.6 per cent. were normal and 63.4 per cent. showed goiter. It was observed that, in the rural portions of the county, the incidence of goiter was about 10 per cent. higher than in the city of Cadillac, which is the only city in the county.

In Houghton County, the most northerly county surveyed, there were 13,725 examined, of whom 8,835 showed goiter, or 64.4 per cent. Of the 6,860 boys examined, 41.9 per cent. were normal and 58.1 per cent. showed goiter. Of the 6,865 girls that were examined, 29.5 per cent. were normal and 70.5 per cent. showed goiter.

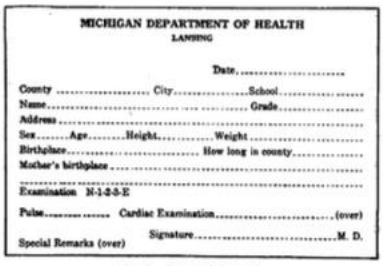
The total number examined in the four counties was 31,612, of whom 14,914, or 47.2 per cent., showed goiter. Of the 15,809 boys examined, 59.5 per cent. were normal and 40.5 per cent. showed goiter. Of the 15,803 girls examined, 46.2 per cent. were normal and 53.8 per cent. showed goiter.

TABLE 3.—*Detailed Results of Survey*

| | Total Four Counties | Macomb County | Midland County | Wexford County | Houghton County |
|---|---|---|---|---|---|
| Number examined | 31,612 | 10,258 | 3,645 | 3,984 | 13,725 |
| Number with goiter | 14,914 | 2,672 | 1,191 | 2,216 | 8,835 |
| Percentage of goiter | 47.2 | 26.0 | 32.7 | 55.6 | 64.4 |
| Boys examined | 15,809 | 5,152 | 1,834 | 1,963 | 6,860 |
| Boys normal | 9,404 | 4,114 | 1,387 | 1,029 | 2,874 |
| Percentage normal | 59.5 | 79.9 | 75.6 | 52.4 | 41.9 |
| Boys with goiter | 6,405 | 1,038 | 447 | 934 | 3,986 |
| Percentage with goiter | 40.5 | 20.1 | 24.4 | 47.6 | 58.1 |
| Girls examined | 15,803 | 5,106 | 1,811 | 2,021 | 6,865 |
| Girls normal | 7,294 | 3,472 | 1,067 | 739 | 2,016 |
| Percentage normal | 46.2 | 68.0 | 58.9 | 36.6 | 29.5 |
| Girls with goiter | 8,509 | 1,634 | 744 | 1,282 | 4,849 |
| Percentage with goiter | 53.8 | 32.0 | 41.1 | 63.4 | 70.5 |
| Normal boys below scholastic grade, percentage | 27.6 | 29.0 | 22.6 | 23.9 | 24.7 |
| Goiter boys below scholastic grade, percentage | 28.4 | 33.0 | 38.5 | 79.2 | 25.9 |
| Normal girls below scholastic grade, percentage | 16.4 | 19.0 | 16.1 | 11.4 | 12.5 |
| Goiter girls below scholastic grade, percentage | 19.8 | 35.0 | 28.2 | 21.2 | 16.2 |
| Normal boys | 9,404 | 4,114 | 1,387 | 1,079 | 2,874 |
| No. 1 goiter (slight enlargement) | 6,324 | 1,037 | 447 | 913 | 3,927 |
| No. 2 goiter (moderate enlargement) | 81 | 1 | 0 | 21 | 59 |
| Normal girls | 7,294 | 3,472 | 1,067 | 739 | 2,016 |
| No. 1 goiter | 8,379 | 1,626 | 743 | 1,201 | 4,759 |
| No. 2 goiter | 179 | 7 | 1 | 81 | 89 |
| No. 3 goiter | 1 | 0 | 0 | 0 | 1 |

| Ages of Patients with Goiter | Total Four Counties | | Macomb County | | Midland County | | Wexford County | | Houghton County | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Boys | Girls | Boys | Girls | Boys | Girls | Boys | Girls | Boys | Girls |
| 5 | 344 | 390 | 39 | 28 | 11 | 13 | 26 | 28 | 187 | 131 |
| 6 | 380 | 431 | 62 | 66 | 23 | 46 | 50 | 52 | 245 | 255 |
| 7 | 490 | 542 | 84 | 104 | 42 | 55 | 67 | 60 | 297 | 314 |
| 8 | 543 | 612 | 94 | 122 | 43 | 56 | 78 | 87 | 328 | 344 |
| 9 | 640 | 690 | 109 | 116 | 52 | 75 | 85 | 112 | 394 | 396 |
| 10 | 706 | 817 | 132 | 168 | 66 | 83 | 97 | 111 | 412 | 435 |
| 11 | 700 | 812 | 132 | 159 | 44 | 61 | 104 | 129 | 420 | 472 |
| 12 | 669 | 891 | 101 | 177 | 48 | 73 | 101 | 129 | 419 | 512 |
| 13 | 645 | 892 | 106 | 184 | 35 | 72 | 113 | 130 | 392 | 509 |
| 14 | 502 | 860 | 87 | 161 | 43 | 67 | 76 | 95 | 356 | 486 |
| 15 | 406 | 740 | 53 | 162 | 28 | 56 | 56 | 115 | 267 | 366 |
| 16 | 298 | 456 | 29 | 73 | 5 | 31 | 37 | 61 | 140 | 200 |
| 17 | 118 | 226 | 15 | 57 | 2 | 21 | 23 | 60 | 78 | 178 |
| 18 | 45 | 175 | 3 | 19 | 3 | 19 | 7 | 30 | 32 | 107 |
| Over 18 | 15 | 50 | 0 | 4 | 0 | 5 | 2 | 22 | 13 | 23 |
| Not given | 24 | 26 | 6 | 9 | 2 | 3 | 0 | 0 | 16 | 14 |

It will be observed that the existence of goiter was uniformly higher among girls than among boys, but not in any such proportion as was found in the reports published of the surveys at Grand Rapids, Akron and elsewhere, the proportion being approximately four girls to three boys. Among the boys, only eighty-one cases were found that classed as a No. 2 goiter, that is, moderately enlarged, and among the girls 179 were found as No. 2. The remainder fell in Group 1, or slightly enlarged. In the entire group, only one case was found of the classification of No. 3, and no cases of exophthalmic goiter.



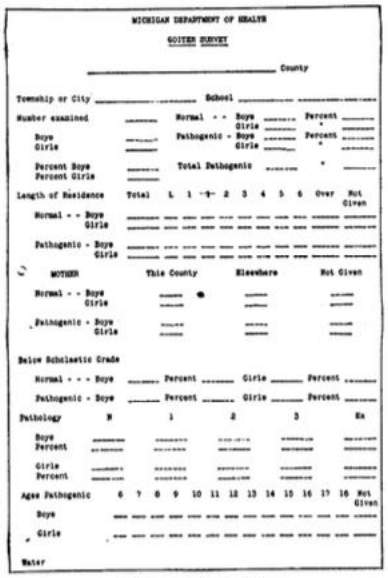
MICHIGAN DEPARTMENT OF HEALTH
LANSING

Date.....

County ..... City..... School.....
Name..... Grade.....
Address .....
Sex..... Age..... Height..... Weight .....
Birthplace..... How long in county.....
Mother's birthplace .....
.....
Examination N-1-2-3-E
Pulse..... Cardiac Examination..... (over)
Special Remarks (over) Signature..... M. D.

Fig. 2.—Examination card.

In the age distribution of these cases, it is found that the greatest number of cases among the boys, that is, the mode of the curve, is found at age 10, whereas among the girls this is found at age 12. This would seem to indicate that congenital cases run approximately even up to age 10, but that these seem to be reduced among the boys after this age, and there is not the


MICHIGAN DEPARTMENT OF HEALTH

GOITER SURVEY

_____ County

Township or City _____ School _____

Number examined _____ Normal - - Boys _____ Percent _____
Girls _____ "

Boys _____ Pathogenic - Boys _____ Percent _____
Girls _____ Girls _____ "

Percent Boys _____ Total Pathogenic _____ "
Percent Girls _____

Length of Residence Total 1 1-2 2 3 4 5 6 Over Not Given

Normal - - Boys _____
Girls _____

Pathogenic - Boys _____
Girls _____

MOTHER This County Elsewhere Not Given

Normal - - Boys _____
Girls _____

Pathogenic - Boys _____
Girls _____

Below Scholastic Grade

Normal - - Boys _____ Percent _____ Girls _____ Percent _____

Pathogenic - Boys _____ Percent _____ Girls _____ Percent _____

Pathology N 1 2 3 Ex

Boys _____
Percent _____

Girls _____
Percent _____

Ages Pathogenic 6 7 8 9 10 11 12 13 14 15 16 17 18 Not Given

Boys _____

Girls _____

Water

Fig. 3.—Compilation sheet.

apparent increase at adolescence that seems to be peculiar among the girls.

In relation to scholastic standing, it was found that among both girls and boys there was a definite increase in the number below scholastic grade among those affected with enlarged thyroid. In some of the counties, this was peculiarly marked. In Wexford County, whereas 23.9 per cent. of the normal boys and 11.4 per cent. of the normal girls were below grade, 29.9 per cent. of the goiter boys and 21.2 per cent. of the goiter girls were below grade. In Macomb County, 29 per cent. of the normal boys and 23 per cent. of the goiter boys, contrasted to 19 per cent. of the normal girls and 25 per cent. of the goiter girls, were below grade. In Midland County, 32.6 per cent. of the normal boys and 38.5 per cent. of the goiter boys, 18.1 per cent. of the normal girls and 28.2 per cent. of the goiter girls were below grade. The difference was the least marked in Houghton County, the normal boys showing 24.7 per cent. below grade, the goiter boys 25.9 per cent., the normal girls 12.5 per cent., and the goiter girls 16.3 per cent. It is probable that scholastic retardation is due to the fact that the disturbance of the function of any organ of the body is reflected to a greater or less degree in mental effort.

Although it was expected that the percentage of goiter would vary inversely with the iodin content of the water supplies, the very sharp difference that occurred in the four counties examined exceeded our expectations and has opened up a large field for detailed study, which will be carried out as soon as weather permits. It was found that localities separated only a few miles varied in percentage of thyroid enlargements in native children from 10 to 100 per cent. One notable instance of this where there are sufficient children for a satisfactory random sample was in the difference in percentage of thyroid enlargement between Mount Clemens, which had 26 per cent., and Romeo, 12 miles distant, which had 75 per cent. Mount Clemens has an iodin content in the city water supply of approximatley 25 parts per billion, while Romeo water does not contain a trace of iodin in 50 liters. There are many other striking variations in the percentage of thyroid enlargement in schools where the environmental surroundings of the children were practically identical. Fifty instances of differences were noted, and samples of water are being examined so that we can present at a later date more detailed numerical relationship between the iodin content of the water supply and the percentage of thyroid enlargement in the community. Our preliminary survey of about 100 samples of water distributed nearly uni-

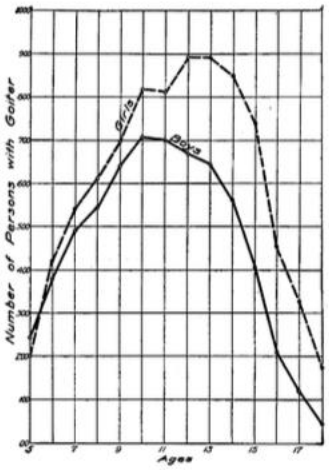



Fig. 4.—Comparative incidence of goiter among boys and girls.

formly over the whole state indicates that we can predict a gradual increase as we pass from south to north in the percentage of goiter from the minimum figures shown in Macomb County to practically 100 per cent., as shown in certain areas in the northern peninsula. Any analysis of the percentage of goiter in relation to iodin content must take into account shipped-in food, and habits of diet, as well as the iodin available in the local food supply, as indicated by the iodin content of

the water supply. Although there is a great deal of work to be done before the final report can be made on the prevalence of simple goiter in Michigan, we believe that the four years' study that has led up to this preliminary report has given us sufficient data so that a method of prevention can be recommended that will be fundamentally adapted to remedying the iodin deficiency for the whole population of the state.

### METHODS OF PREVENTION

While it is almost universally agreed through the civilized world that iodin deficiency is the cause of simple goiter,[8] there has been a great deal said, pro and

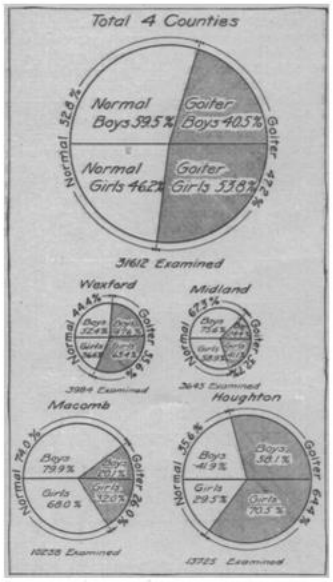



Fig. 5.—Incidence of goiter among boys and girls in four counties.

con, as to methods of supplying iodin. Up to date, the most satisfactory method that has been in use is that of giving 10 mg. of sodium iodid in a chocolate tablet, or 10 mg. of iodin as iodostarine in a chocolate tablet once a week for forty weeks to all children in the schools, thus supplying from 300 to 400 mg. of iodin a year.[9] While results of this method have been very spectacular in the reduction of the percentage of individuals showing thyroid enlargement, and the medical profession in the United States and in Europe is endorsing the procedure, it is open to several administrative objections: 1. It does not reach the children early enough in the rural districts. 2. It does not reach the pregnant mother. 3. It must depend on local interest and knowledge of the subject. 4. There must be constant propaganda in every community to keep the procedure in effect. 5. Persons overtreat themselves with these products. 6. The cost, while very small, will militate against the procedure because it is a specific cost and can be focused on for discussion. 7. Results cannot be made apparent except by resurvey: obviously, in many instances in which the scheme had once been tried out, it would be dropped from lack of knowledge as to the results obtained.

It has been proposed that iodin be given in municipal water supplies, and tried out at Rochester, N. Y., Sault Ste. Marie, Mich.,[10] and elsewhere. While this method is perfectly possible, it is open to the objection that only an infinitesimal amount of the water, less than 1 per cent., that is pumped by a municipality is used for drinking purposes, and only the municipal population can be reached.

The third method, which has been proposed and has not been tried out, is that of requiring by law that all salt sold for human and animal consumption in goitrous areas contain sufficient iodin so that the minimum requirements of 300 mg. a year would be normally taken in by every one in the area. When this method was first proposed in Michigan, two years ago, in a conference that was held with one of the officers of the Salt Manufacturers Association, the statement was made that it could be done provided the public was sufficiently well informed so that there would be no criticism of the product and provided that there was a good, sound, scientific background for the procedure. This method is open to fewer objections than any of the other methods, as it is a natural way of correcting an environmental deficiency of iodin content in the natural food supply, and will furnish no greater amount of iodin than is supplied naturally in communities which do not have a goiter problem owing to the fact that they have ample iodin in the soil and water. This procedure is in line with many other tendencies in the field of nutrition, away from overrefinement which eliminates much of the food value. Crude salt almost universally contains some iodids, and the statement has been variously made that refinement of the salt is one of the principal contributory causes of the increase of thyroid enlargements in the United States.

Supplying iodin deficiency through a household necessity would eliminate practically all administrative detail, would do away with the necessity of continued educational effort, would arouse individual action, and would solve the problem for both urban and rural districts.

8. Marine, David; and Williams, W. W.: The Relation of Iodin to the Structure of the Thyroid Gland, Arch. Int. Med. **1**:345 (May) 1908. Marine, David; and Lenhart, C. H.: Further Observations on the Relation of Iodin to the Structure of the Thyroid Gland in the Sheep, Dog, Hog and Ox, ibid. **3**:66 (Feb.) 1909; Relation of Iodin to the Structure of Human Thyroids, ibid. **4**:440-493 (Nov.) 1909; Pathological Anatomy of Exophthalmic Goiter, ibid. **8**:265 (Sept.) 1911. De Quervain, F.: The Thyroid and Iodin in Relation to the Prophylaxis of Goiter, Schweiz. Apoth. Ztg. **61**:365, 1923.

9. Marine, David; and Kimball, O. P.: The Prevention of Simple Goiter, J. Lab. & Clin. Med. **3**:40 (Oct.) 1917; The Prevention of Simple Goiter in Man, Arch. Int. Med. **22**:41 (July) 1918; J. A. M. A. **73**:1873 (Dec. 20) 1919; Arch. Int. Med. **25**:661 (June) 1920; J. A. M. A. **77**:1068 (Oct. 1) 1921. Kimball, O. P.: The Prevention of Simple Goiter in Man, Am. J. Pub. Health **12**:81 (Feb.) 1923. Klinger, R.: Prophylaxis of Endemic Goiter, Wien. klin. Wchnschr. **35**:35-37 (Jan. 13) 1922; abstr. J. A. M. A. **78**:1175 (April 15) 1922.

10. Iodin Treatment of City Water at Sault Ste. Marie, Mich., Water Works **61**:361 (Feb. 13) 1924.

**Intravenous Use of Organ Extracts.**—As a general principle, organ extracts of unknown composition (and this includes all of them, except thyroxin, epinephrin and, with some reservations, pituitary extract and insulin) must not be given intravenously or hypodermically when repeated administrations are called for. We must clearly recognize that intravenous or hypodermic therapy is always unphysiologic, and should be used only with pure products, and when the oral route yields no results, or too slow effects.—Carlson, A. J.: *Proc. Inst. Med. Chicago* **4**:205, 1923.

# APPENDIX D. GRADING RUBRICS

| Grading Rubric. Question 1 on Problem Identification | | | | |
|---|---|---|---|---|
| | **Below Average** | **Average** | **Superior** | **Outstanding** |
| **Content** | A numbered list with issues that do not make sense as high priorities | A numbered list that shows some basic understanding of the case. | A numbered list of issues with some thought about what makes an issue more or less important. | A numbered list of issues with each item's high priority explained and referenced. |
| **Quality of Analysis** | Limited insight is shown in discussing the issues | Analysis is similar in depth to Gen AI without any connections being made to public health practice | Shows an understanding about what a state health department can do and should do. | Issues are classified by importance and whether they can be acted on feasibly. Applies concepts and principles from public health functions. |

| | **Grading Rubric. Question 2 on Proposed Approaches.** | | | | |
|---|---|---|---|---|---|
| | **F** | **D+ / D** | **C- / C / C+** | **B- / B / B+** | **A- / A / A+** |
| **Content** | Failed to grasp approaches and its viability in all given context | Limited insight into what approaches have promise. Ignores political and social context. | Anchors on one approach and fails to consider viability of all solutions. | Approaches are reasonable but the exposition of reasoning is not clear. | Creative solutions with clear cogent critical analysis of each informed by context. |
| **Quality of Analysis** | Lack of or limitations in appreciation of the context and the case study overall | No system for assigning pros and cons of approaches. | Can see some semblance of reasons for and against each approach. | Insightful assessment of each approach. | Develops a framework to rank each solution on both feasibility and impact. Approaches linked to context and to public health as a discipline. |

| | **Grading Rubric. Question 3 on Stakeholder Analysis** | | | | |
|---|---|---|---|---|---|
| | **F** | **D+ / D** | **C- / C / C+** | **B- / B / B+** | **/ A / A+** |
| **Content** | Fails to identify relevant stakeholders | Limited insight | Misses out on key stakeholders | Stakeholders list is complete | Thorough listing informed by context and history. |
| **Quality of Analysis** | Misses influence of stakeholder and relevance is off-point | No system for listing. | Some characteristics listed | Insightful assessment of each stakeholder | Develops a framework to rank each stakeholder's power and impact. |

| | **Grading Rubric. Question 4 Barriers to Solutions in 21st Century** | | | | |
|---|---|---|---|---|---|
| | **F** | **D+ / D** | **C- / C / C+** | **B- / B / B+** | **A- / A / A+** |
| **Content** | Insight into principles unclear | Limited insight into principles. | Simple answers like "It's poverty" | Extra insight into economic and social context. | Shows mastery of principles of public health in analyzing root causes of health system incapacity. |
| **Quality of Analysis** | Fails to reason using public health principles | Unclear reasoning | Pedestrian rote answers. | Taps on some principles of public health. | Utilizes a systematic approach linked to context and to public health as a discipline. |