Some Contributing Factors to the Degenerative Diseases, with Special Consideration of the Rôle of Dental Focal Infections and Seasonal Tides in Defensive Vitamins

By Weston A. Price, D.D.S., M.S., F.A.C.D., Cleveland, Ohio

(Read before the Philadelphia County Medical Society (Stomatology Night), Philadelphia, Pa., April 16, 1930; reprinted from the Dental Cosmos for October and November 1930.)

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With the lessening and control of the epidemic infectious diseases, the so-called degenerative diseases have come to command the chief concern and effort of specialists in the various departments of health conservation. Since organ and tissue degenerations develop with progressive frequency with increasing age, they will logically be expected to appear in increasing numbers of individuals who, through the removal of the epidemic acute infectious diseases, have been permitted to live to an age when those degenerative diseases would develop.

With the emphasis which during the last fifty years has been placed upon the rôle of the invading organism as the all-important causative factor, as clearly demonstrated in the acute infection processes, it has come to be part of modern thought that degenerating tissues in any part of the body when found to be infected had their principal, if not only cause in the entrance into that tissue of the invading organism. It has been very natural, therefore, that practically all the emphasis in many quarters has been upon the portal of entry of the bacterium invading the degenerating organ. Since the portal of entrance seemed to be demonstrated in large numbers of cases to be a focus of infection in nonvital or degenerating tissue, the emphasis in the treatment of degenerative diseases in many instances has taken the form of a search for the focus and an effort at its removal, on the presumption that thereby all the contributing factors would be eliminated.

Since infected teeth have been found to harbor a type of organism, the streptococcus, not only known to be competent to produce serious local and systemic disturbances but also practically always present in infected dental tissues, it has been most natural that great emphasis has been placed upon dental infections and the need for their elimination. Indeed, it has been frequently stated that the discovery and practical application of the principle of focal infection constitutes one of the greatest single advances in the history of medicine. At the same time, few single problems in the history of medicine and dentistry have been associated with or attended by such striking differences of opinion.

The degenerative diseases constitute so important a place in the afflictions of mankind today, particularly in those communities where the revelations of modern science have made means available for greatly reducing infectious diseases, that one of the most urgent problems of the hour is to discover the causes of these so-called degenerative diseases and through that knowledge provide means for their prevention and correction. The importance that is given to the probable contribution to degenerative diseases of infections from a focus sug-

gests that this process is in many quarters considered today to be the most important factor in the correction of these degenerative processes.

It has recently been stated with regard to one of the very large hospitals of our country that in the consideration of medical cases 90 per cent of the medical service consists in searches for foci of infection. The changed attitude of the medical and dental professions, particularly throughout the middle west of this country, indicates that a large number of the specialists in the various departments of medicine, particularly those in general medical practice, have come to place very great importance on focal infections as important contributing factors to the degenerative diseases. It is also of great importance and significance that practically universally now dental tissues are deemed to be the most common single locations of focal infections that are considered causative of degenerative processes. This has been brought about by the rapidly growing mass of clinical data which have emphasized the great importance of removing dental foci. The clinical data are being continually supported by painstaking laboratory investigations.

There are many reasons why dental foci are both the most frequent sources and the most serious location of foci of infection. Some of these are as follows:

(1) They practically always contain streptococci, though other organisms may be present.

(2) The physical nature of a non-vital tooth structure provides not only physical protection from the defensive elements of the body, but contains gradients in the food elements suitable for developing biologic changes in the contained organisms. These are expressed as changes in virulence or changed affinities.

(3) They contain infection which is inside the body's surface defenses and the organisms and toxins have direct access to the blood and lymph circulations of the body and are often forced into these circulation systems under pressure. The pabulum constituting the nutriment for the organisms is provided by tissue fluids which can as readily modify the organisms in that environment as can various culture media in artificially produced envirouments. The influence of an organ lesion on the body fluids and therefore on the pabulum providing the food for the organisms growing in their encasements in the infected tooth has not been generally appreciated or sufficiently emphasized.

Instead of thinking of localization entirely in terms of the organism and as a fixed biologic quality, let us observe some evidence dealing with the sources of these specific attacking or electing qualities. Why is it that, while different strains of streptococci of dental origin obtained from different individuals may or may not show a special preference as to the organ selected for localization, there may be a marked preference and one which can be anticipated to some extent by knowing the organ lesions of the individual furnishing the infected tooth, that is, who has nourished it. For studying this I have used data from three authors who have had much experience in animal inoculations and have published many data. The authors selected have been Rosenow, Haden and Price, and the data used here are taken from the following articles:

Edward C. Rosenow, M.D. "Experimental and Clinical Studies on Focal Infection and Elective Localization: New Findings and their Significance." *Journ. A. D. A.*, October 1924, p. 963; also, "Studies on Elective Localization—Focal Infection with Special Reference to Oral Sepsis." *Journ. Dental Research*, September 1919, Vol. I, No. 3, p. 205.

Russell L. Haden, M.A., M.D.: "Dental Infection and Systemic Disease." Lea & Febiger, 1928.

Weston A. Price, D.D.S., M.S., F.A.C.D.: "Dental Infections, Oral and Systemic," Vol. I, Chap. xxii. Penton Pub. Co., 1923.

It is of interest to note the similarity of the results obtained by these workers in widely separated places. I have used only four organ affections; namely, kidney, heart or vascular disease, eye, stom-

ach and duodenum. These are shown in Table I. When we read the data given in this chart from left to right we see characteristics of the individual rabbits and groups of rabbits, with a high average increase in affinity for that organ in the rabbit which was particularly involved in the patient furnishing the dental culture. A study of the data by reading up and down reveals a diseased organ influence of great importance. In this examination of the data we are paring the ratio of incidence of localization in the organ that was affected in the patient from whom the culture was taken, the organ group average incidence ranges as follows: For kidney, 17 to 1; for heart, 6 to 1; eye, 4 to 1; stomach and duodenum 10 to 1; with a general average increase of incidence of 9 to 1 for localization in that organ or tissue from which the patient was suffering.

A diseased organ apparently influences the bacterium through its food and en-

TABLE I

RELATION OF ANIMAL LOCALIZATION TO PATIENT'S DISEASES

Cultures from patients with	Author	No. of Animals	No. of Patients	Percentage of animals showing lesions in: Kidney	Endocardium	Myocardium	Eye	Stomach and duodenum	Average Ratio	General Average
Kidney Infection	Rosenow	5	15	80	7	7	0	0	22 to 1	
	Haden	48	10	85	4	4	6	6	17 to 1	
	Price	9	3	76	0	22	0	0	12 to 1	
Heart or Vascular Disease	Rosenow	10	3	30	50	10	0	30	3 to 1	
	Haden	46	11	30	67	37	4	13	8 to 1	
	Price	31	7	38	38	58	0	0	8 to 1	
Eye Infection	Rosenow	5	1	0	20	0	60	20	6 to 1	
	Haden	142	30	33	14	10	65	6	4 to 1	9 to 1
	Price	56	6	30	16	32	68	7	3 to 1	
Stomach and Duodenum	Rosenow	90	40	3	1	7	0	68	22 to 1	
	Haden	141	30	22	12	12	5	61	5 to 1	
	Price	12	3	33	8	25	8	68	4 to 1	
Av. increase in localization qualities	Gen. Av. 9 to 1			3 to 1	5 to 1	3 to 1	26 to 1	7 to 1		

STUDY OF AREA OF LOCALIZATION IN ANIMALS AS INFLUENCED BY THE ORGAN OR TISSUE HAVING LESIONS IN THE PATIENT FURNISHING THE INFECTED TOOTH USED FOR THE CULTURE. DATA TAKEN FROM THREE AUTHORS.

studying the differences in the specific localizing qualities of the organism, depending upon whether that particular organ was or was not affected or diseased in the individual from whom the cultures were obtained from a dental infection. There is an average increase in localization of ninefold, ranging from 3 to 1 for kidney, 5 to 1 for endocarditis, 3 to 1 for myocarditis, 26 to 1 for eye and 7 to 1 for stomach and duodenum. We see at once evidence of a vicious cycle. When reading across the chart and comvironment, creating an affinity. The organism and its toxins are predisposed toward or have a special affinity for that organ tissue. Individuals with definite defense for certain tissues, usually spoken of as susceptibilities, inherited or acquired, carry a special danger or menace in infected pulpless teeth, and the evidence indicates that nearly all pulpless teeth become infected early, if they are not already so when the roots are filled.

There are many contributions to both

clinical and laboratory data which throw light upon these specific localizing qualities of streptococci from dental foci. The following illustration from the author's data is quite illuminating. A boy fourteen years of age, whose case is not included in the above chart, was studied for possible dental contributing factors to acute rheumatism. About six weeks previous to this time he suffered severely from an acute pulpitis or toothache in the first permanent molar, which had deep caries. He was found to have already developed acute endocarditis. The pulp was still vital with no evidence of exposure. On removal of the tooth the pulp was cultured and inoculations made into thirty rabbits, using 2 cc. of a twenty-four-hour culture. Twenty-eight of the thirty rabbits, or 93 per cent, developed acute heart involvement and all thirty, or 100 per cent, developed acute joint involvements. This strain rapidly lost its virulence when grown in artificial culture media, for when injected into ten rabbits seventeen days later only 10 per cent developed heart involvement. In spite of excellent hospitalization and medical care this boy died of endocarditis in about seven months.

There is much misapprehension regarding the size of the dose or the quantity of organisms necessary when the elective localizing quality is highly specific, the claim being that laboratory studies by inoculations largely lose their significance because the animals are overwhelmed with large doses. The following throws important light on this misapprehension. Cultures taken from teeth from thirty-nine patients inoculated in fifty-nine rabbits caused death in an average of seven days, with an average weight loss of 20 per cent. The size of the dose of a twenty-four-hour culture was from one-eighth of 1 cc. to 2 cc. This point is still better emphasized by the following, which shows the exceedingly small quantity of infection that can do serious harm when a specific organ-attacking quality has been developed in the organisms growing in the dental focus. Two infected teeth from a patient, twenty-six years of age, with acute endocarditis were ground up in a sterile salt solution and, after settling, the nearly clear liquid was injected into a rabbit's ear vein. The rabbit died in about two weeks' time of acute endocarditis with a valvular vegetation one inch long. The quantity of organisms was estimated by making a count from a sample of the material injected and by calculation was estimated to be less than one-millionth part of a gram. The young man from whom the culture was obtained, with an otherwise splendid physique, had his life ruined through his incapacity from this heart involvement.

These data strongly suggest that organisms develop an exalted virulence and attacking power due to the pabulum providing their growth in the focus. An important phase of this study at this point would involve an extended consideration (which space does not permit) of factors contributing to the development of those qualities of exalted virulence in the organisms, assuming that on its entrance into the dental tissues which become a focus the bacterium has a much lower virulence and attacking power.

It has been shown by many workers, particularly the three quoted above, that the ordinary strains of streptococci of the mouth in healthy individuals usually have exceedingly low virulence. I have shown[1] that a fecalis strain of streptococcus was found in the lesions of experimental animals in 65.5 per cent of sixty-seven successive cases, for mitus in 7.5, and salivarius in 1.5. I have shown further that the chemical environment of strains of salivarius by the addition of irritants or depressants may change their morphological characteristics from a salivarius over to a mitus and later to a fecalis, demonstrating that it would be entirely feasible for the dental environment, due to characteristics of its nutrient pabulum, to greatly change the organisms.[2]

This, of course, is abundantly demonstrated by animal passages by which the contact with the body fluids as culture media may enormously increase the virulence.

The unit characteristics of the body fluids which directly and indirectly contribute to the nutriment and environment of organisms in the focus are apparently influenced also by factors that are transmissible or inheritable. I have, for example, shown[1] that susceptibility of an individual can be either or both inherited or acquired, and further, that there is a marked difference in the susceptibility where it is inherited from one or both sides of the ancestry. In a study of 650 susceptibility charts or genealogical trees selected for their completeness from 1400, it was found that when a degenerative lesion appeared in a patient and one of his ancestors its incidence was greatly increased in the other descendants as compared with those cases where it did not appear in an ancestor. For example, a selection of ten individuals with heart involvement showed fifty-seven other members of those same ten family groups to have heart involvement. When, however, ten families were selected because the patient had involvement of the nervous system there were only nine individuals who had heart involvement, while 142 in the ten family groups had involvements of the nervous system. Similarly, for ten individuals with involvement of degenerative processes in internal organs, only nine other members of the ten family groups had heart involvement, while ninety had involvement of internal organs. Hurst has given the details of a genealogical tree where sixteen of twenty-eight members of the family had nephritis. We, accordingly, must place much emphasis on the susceptibility of the host as determining the quality of the soil for bacterial growth. It has been suggested that 60 per cent of individuals die of the same cause as that of one of the parents. From these data, which are typical of a great quantity that can be cited, we see urgent need for the prevention of dental and other focal infections on the one hand and for the reduction of all contributing factors that will add to the inherited and acquired susceptibilities on the other.

My critical study of large numbers of individuals reveals that 94 per cent of those with a history of heart involvement also had a history of very rapid and extensive dental caries in childhood[1] very much above the average of those who had not suffered from organ involvement. In this connection, when we realize that 90 per cent of individuals who develop heart involvement do so before ten years of age, we have a strong suggestion of a relationship primarily as common effects of common causative factors, whether contributing or not. Further, when we realize that the available data seem to indicate that dental caries is on the increase in many districts and similarly that heart involvement would seem to be on the increase and chiefly in certain areas, we have the suggestion again of common contributing factors.

My approach to this problem will be from the standpoint of a study of some of the factors that seem to be commonly contributing or causative factors for several degenerative processes. The emphasis in the selection of dietaries in the past has largely been on the basis of energy production. During the last decade the emphasis is swinging to the importance of a balance in activators, some of which are the known vitamins. I have, accordingly, of late put much less of my effort upon the study of the physical and histological characteristics of the dental lesions in their various stages of development and much more upon the obscure forces which are the controlling factors in their presence or production, to the end that they may be prevented.

It is my belief that the lack of progress in the past has been largely the result of a mistaken premise. I would, accordingly, state briefly a few of the viewpoints that have prevailed, why I think they are untenable, and my new viewpoint, which will be supported by experimental data.

(1) Dental caries has been largely considered to be a local disease produced chiefly by contributing factors which are local in the mouth. I interpret the new data as indicating that dental caries is primarily the result of a disturbed phys-

ical state or, otherwise stated, is a systemic condition produced primarily as the result of nutritional deficiencies.

(2) Dental caries has been considered to have its chief significance in the injury to or loss of the dental organs as part of a local disease. I interpret the data as indicating that it is primarily a local expression of physical disturbance which, at the same time, may be producing more or less serious injury to other organs and tissues of the body which, because they have an adequate circulation (unlike the tooth lesion) may in large part recover.

(3) Dental infections have been considered to be similar to infections in other structures of the body. I believe that infected tooth structure is not comparable to infection in other tissues, but that it constitutes a harboring place for organisms which, in the case of the infected pulpless tooth, will be so difficult to eliminate and so easy to become reestablished that treatment will give very little assurance of complete and permanent success. Further, that the environment within infected tooth structure provides conditions for the development of very marked changes in the organism that has invaded it (which is practically always a streptococcus), and that the organism can develop biologic changes which give it powers of attack upon special tissues without calling forth an adequate reaction of the host sufficient to maintain an adequate quarantine about the tooth.

(4) The x-ray has been supposed to reveal dental infection because the effect of the infection has been presumed to include structural change in the bone surrounding the tooth in the form of an area of radiolucency. I believe the lessened density of the bone, when it exists about the apex of an infected tooth, is primarily the result of a defensive reaction on the part of the host, and if the host does not have an ample defensive reaction there will be very little, if any, structural change; or there may even be a condensation, and without the establishment of the quarantine station the bacteria and their products will have more ready access into the tissues of the host, as abundantly supported by the work of several workers, especially Rosenow, Haden and myself.

(5) It seems to have been taken for granted that dental infections do not produce important changes in the blood of the patient. I have included in my studies quite extended blood chemical analyses of over 1800 cases and have found marked evidence of the development of imbalances which have frequently improved or corrected with the removal of dental infections.

(6) It has been assumed that the extent of the area of rarefaction or radiolucency about a tooth is a measure of the quantity of infection (which I have demonstrated to be in error), and also that so-called x-ray negative teeth are not infected and therefore are not to be considered a source of danger. My data and those of Haden and several others, particularly Rosenow, have demonstrated that x-ray negative pulpless teeth may not only be infected with a virulent strain of streptococcus, but also that the incidence of organ and tissue involvement in animals is approximately as high as in the case of so-called x-ray positive teeth, those showing marked evidence of apical involvement. Data as provided by Haden and myself are shown in Table II, in which it will be seen from the Haden series that the x-ray negative teeth showed only a little less incidence of infection than the x-ray positive teeth, while in my series the x-ray negative teeth showed a distinctly higher percentage of incidence of lesions in rabbits than the x-ray positive teeth. In addition to data expressing general localizations (A), I have shown in (B) comparative localizations in the same tissue of rabbit as that of patient. In this group the localizations are twice as great in the radiographic negative teeth as in the radiographic positive teeth. It is very clear that these teeth cannot be dismissed from responsibility as on the old basis of diagnosis.

Since dental infections are so difficult both to find and to eliminate and because of the very large clinical experience sup-

porting the view that dental infections can produce serious systemic harm under favorable conditions, I deem it to be exceedingly urgent that the dental caries which precedes the pulp involvement and also the degenerations of the tissues about the teeth, such as pyorrhea, shall be prevented as completely as possible. If dental caries is chiefly a degenerative process due primarily to a deficiency (which my published data indicate and these new data support) we should not hope to find the evidence by continuing our study of the histologic characteristics of the lesions, since bacterial invasion must be expected to be found where favorable conditions for bacterial growth obtain. My approach to the problem, therefore, is by way of the forces that are at work in producing these lesions.

Since life requires for its normal maintenance not only energy-producing food factors but also activating substances, we may perhaps compare these to the gasoline used by the gas engine, which alone produces no energy, and the spark as provided by a battery. We should naturally, therefore, look for ample sources of the activators and associate their presence or absence with degenerations such as dental lesions. A search for the activators that may be responsible will naturally lead to a study of the foods that come nearest to supplying all the requirements of the body. A typical balanced food should be expected, therefore, to be found in the most perfectly developed milk products, since milk is the most universal food and is the only food known that contains all the food elements which the new-born child requires for life and growth. It is the most commonly used food for adults in illness and in cases of severe exhaustion, and, further, it is the food of all the mammalia in infancy. Studies of milk and its products in the past have largely dealt with the mineral, fat, sugar and protein content, which could not explain why two samples of milk with apparently the same chemical constitution might have very different capacities for maintaining life, and why some cows could not raise their own calves. It has been known for some time that in the effort to make up a synthetic milk, the purer the product the shorter the life of the animal. Manufacturers of oleomargarine have formerly been required by law to provide in their product certain

TABLE II

LESIONS IN RABBITS FOLLOWING THE INJECTION OF BACTERIA FROM DIFFERENT RADIOGRAPHIC GROUPS OF TEETH

(A) GENERAL LOCALIZATIONS				Percentage of animals showing lesions in							
Author	Group	No. of patients	No. of rabbits	Joint	Kidney	Muscle	Endocardium	Myocardium	Brain	Eye	Stomach and duodenum
Haden	Radiographic negative teeth	89	232	59	36	24	17	9	3	13	7
	Radiographic positive teeth	93	224	63	34	22	16	12	5	13	16
Price	Radiographic negative teeth	48	206	16	22	21	12	23	2*	13	40**
	Radiographic positive teeth	70	307	13	16	14	6	16	3*	8	32**
(B) LOCALIZATIONS IN SAME TISSUE AS PATIENT											
Price	Radiographic negative teeth	37	83	11	0.4	13	9	18	0.4*	8	3**
	Radiographic positive teeth	35	71	4	0.3	6	4	9	2*	4	0.3**

*Nervous system
**Digestive tract.

Data from two authors indicating the comparative safety of so-called x-ray negative and x-ray positive teeth. These show about an equally large number of general localizations in rabbits for the two groups. A greater number of specific localizations appear in my groups in the negative series from patients suffering from organ involvement.

percentages of butter because without the butter the oleomargarine would not sustain life.

With the coming of the knowledge of the rôle of the vitamins and the identification of a few of them, a new approach to this whole problem has been made possible and milk and its products can now be evalnated in part in terms of some of these accessory food factors which are known to be indispensable to life. The levels of some of these accessory food factors in a few individual samples of milk have been determined, but so far as I know no data have previously been made available (except my progress reports) indicating for large numbers of samples the difference in the levels of the fat-soluble vitamins A and D and associated activators in milk-fat, as cream or butter, for the same places for different months of the year and for different places at the same time, for comparison.

I have discussed the relative merits of biologic and colorimetric tests and the comments and criticisms of several authorities with regard to the relative values of different methods in previous papers.

Since animal life can only be maintained by using as food either plants or animals that have eaten plants or plant-eating animals, we have an opportunity to study some phases of variations of plant life constituting our food by studying milk. The water-soluble vitamins being quite readily obtainable from other sources than milk and since the fat-soluble vitamins A and D and particularly D are difficult to obtain, I have placed the emphasis in these studies on the variations in the levels of vitamins A and D, and for reasons which I have explained in other articles I am using chiefly chemical methods for the determination of certain of these factors, together with the feeding of animals. My clinical studies have included several hundred humans, for many of whom blood chemical studies have also been made.

In one of my recent research reports[3] I presented data indicating the changes produced in the blood of chickens by various activators, including butters of different vitamin content. This showed a marked difference in the effect on chickens whether the butters were high in both A and D, high only in A and low in D, or low in both A and D. That paper also reported evidence of the beneficial results of high-vitamin butters in the treatment of certain clinical conditions, including ununited fracture, and also studies on cod-liver oils.

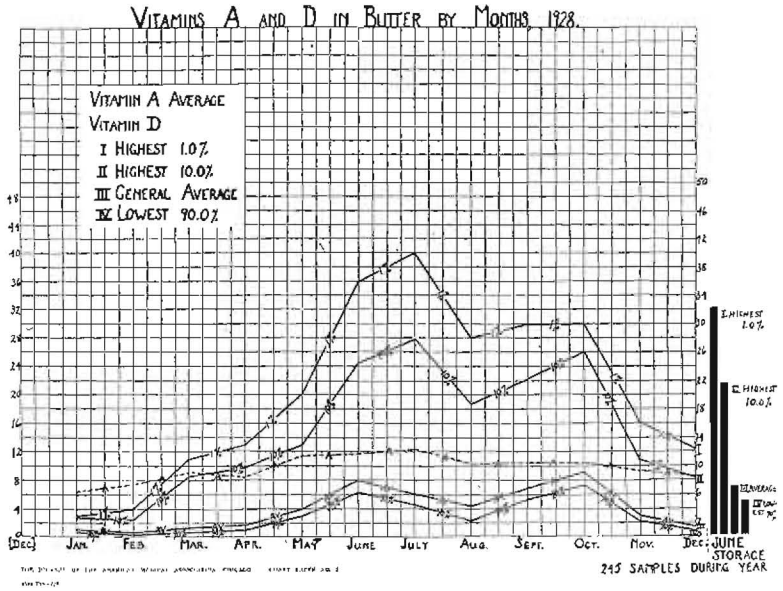
Beginning with the year 1927 I made studies of the varying levels of the vitamins in dairy products for different places at different seasons. These studies have been continued and I now have very complete curves for a large number of places for 1928 and 1929, as well as similar curves in progress for 1930. During 1928 the studies embraced the product of five states. In 1929 and 1930 they have been extended to include not only a general distribution of places throughout the North American continent, but also many other countries of the world. These are including approximately 400 places from which samples are received every one to four weeks. Detailed information is accumulating for different areas regarding the types of rations used, physical characteristics of the soil, and through government reports the rainfall, sunshine, etc. The data disclosed by these studies are revealing very important characteristics through the variations in vitamin content from month to month for the different years, which variations, with significant exceptions, are repeating themselves with remarkable constancy for the same areas for three successive years.

In Fig. 1 will be seen the levels of vitamins A and D for five states as determined from month to month. Vitamin A is shown in the broken line and vitamin D in four factors in the solid line. The upper solid graph is the highest, 1 per cent, shown as No. 1; No. 2, the level of the highest, 10 per cent; No. 3, the general average, and No. 4, the level of the lowest, 90 per cent. It will be seen immediately that the vitamin content is very low during the winter

and spring months, rising in the early summer, falling with the heat of midsummer, rising again in the fall, with a rapid decline at the beginning of winter and maintaining that low level throughout the winter season. At the extreme right in the solid column are shown the levels for storage butters of the previous June for the same four groupings of vitamin D; namely, the highest, 1 per cent; highest, 10 per cent; general average and lowest, 90 per cent. About 245 samples of storage butter are included in these determinations. It will be seen that the various groupings show approximately the same levels as did the fresh butters tested in June 1928. This indicates the splendid keeping quality of the vitamin-D factor in the butter placed in storage.

It may be of interest that the butter that has been used in my home this winter and spring has been almost entirely the June butters of 1928 that were placed in low temperature cold storage because of their high vitamin content. The results have been most gratifying. A series of graphs for a single cycle of seasons as expressed in one year might readily be expected to be dominated by local variable factors. I accordingly delayed publication of those important data as obtained in 1928 until sufficient observations could be made in 1929 to make comparisons possible to observe whether we were dealing with fundamental causative factors associated definitely with seasons. I now have data for all of 1928 and 1929 for comparison, and for the first three months of 1930. It is exceedingly significant that the curves for the two years are very similar, the variations being limited almost entirely to the summer months, when there was a distinct difference in the precipitation and heat of the two years. This chart is omitted for want of space. The marked similarity seems to demoustrate strongly tbat we are not dealing with any oue factor such as sunshine.

FIG. 1



These graphs show the monthly levels of vitamin-A and vitamin-D in the butter samples received from five states during 1928. D is in 4 percentages. At the extreme right are shown the same values for vitamin-D for the June storage butter of the year before (1927).

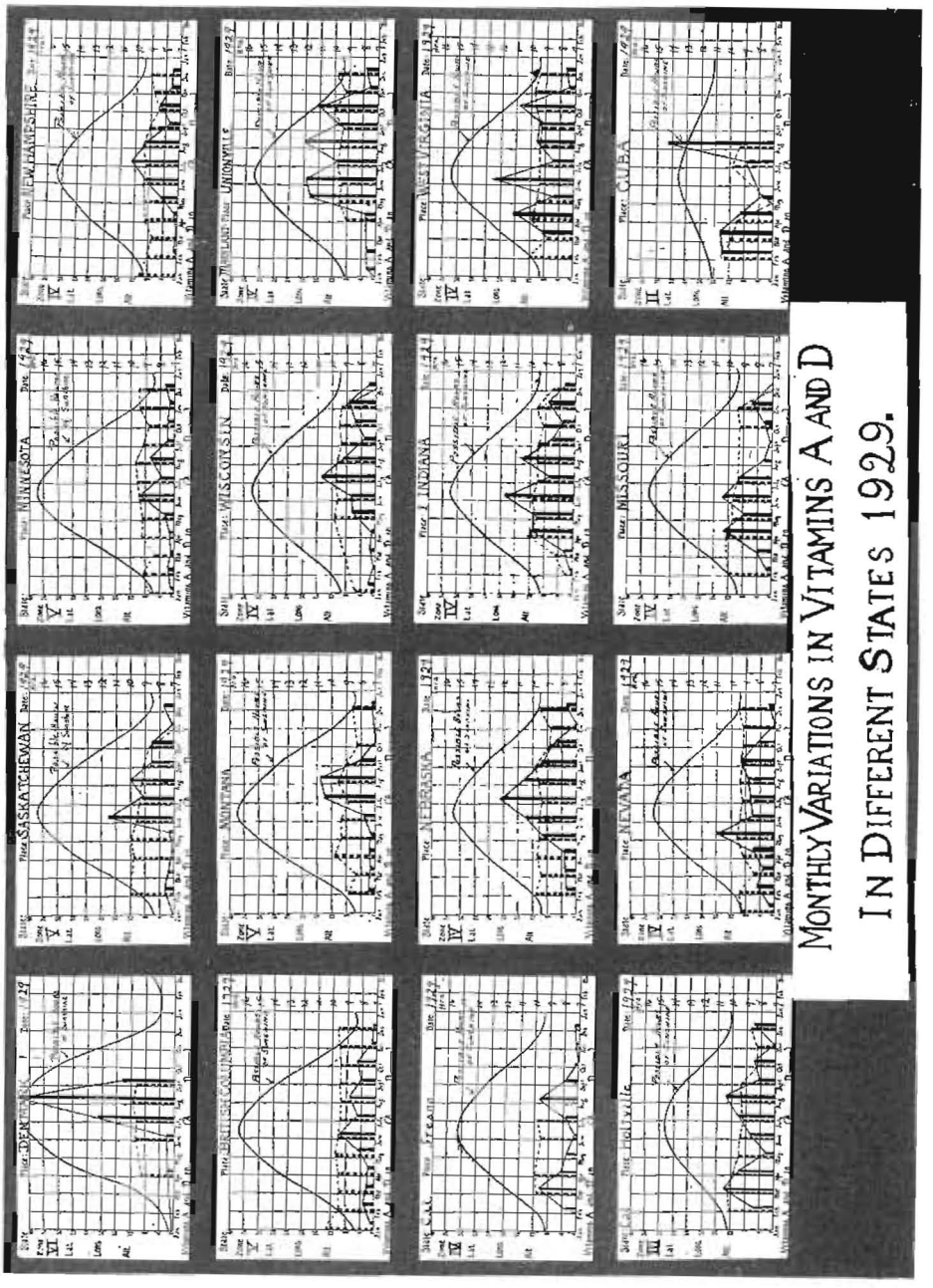


FIG. 2

Typical states or provinces are shown from five ten-degree latitude zones. Vitamin-A is shown by months in broken columns and broken lines and vitamin-D in solid. Note that the vitamin levels do not necessarily follow the possible hours of sunshine.

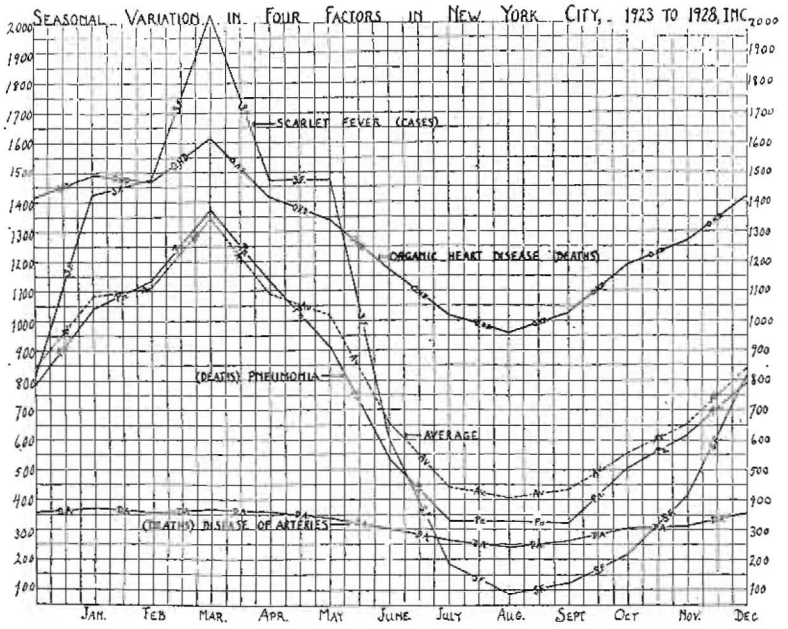
During 1929 and 1930 data similar to those obtained for the five-state area have been and are being obtained for nearly all the populated districts of the United States and Canada. A group of sixteen districts distributed throughout the United States and Canada, with one from Denmark, will be seen in Fig. 2.

For convenience in studying the influence of distribution of sunshine and geographic location, I have divided the countries being studied into ten degree latitude zones. The zones are shown at the left side of the charts for the different states or provinces and the total possible hours of sunshiue are also shown. Zone I is from 5 degrees north latitude to 15; Zone II, 15 to 25; Zone III, 25 to 35; Zone IV, 35 to 45; Zone V, 45 to 55; Zone VI, 55 to 65. Zone VI includes northern Canada, Denmark and parts of Alaska. This divides the countries into belts east and west. By referring to Fig. 2 it will immediately be seen that in the northern latitude zones vitamin D does not start rising until summer, whereas in several of the southern states of America and in Cuba it reaches its peak early in the year, in some instances showing curves conspicuously the opposite of the sunshine curve.

The accumulating data suggest that the rise in vitamin D corresponds with the period in which the cows are eating a rapidly growing new grass or similar fodder. Several factors are readily apparent from this chart, among them the marked difference iu the period of the peaks in different locations, particularly the difference in the height and length of duration of the peaks.

As the purpose of these studies is to obtain data which will throw light upon the causes of the various morbidities, including dental disease, I wish at this time to present data which relate to the

FIG. 3



The means for several morbidity and mortality curves for six years in New York City follow the same general configuration by months. This is shown as being typical of these diseases for many other cities.

variations in the incidence of morbidities and mortality for different countries and for different districts in the same country, and to make a comparative study of the morbidity curves with the vitamin curves which I have just presented. If space permitted, there would be presented graphs for comparison of the mortality rates by months for the United States of America and England and Wales for the two diseases, pneumonia and organic heart disease. These graphs show remarkably similar levels. It seems impossible that such marked similarity of so fundamental a measure of vital capacity could exist except as a result of common causes. The forces at work are evidently quite fundamental for the maintenance of life and we should expect that variations in the intensity of these forces would produce variations in the results or, conversely stated, variations in results for different places might be expected to be an expression of variations in the intensity of these forces. This immediately suggests an analysis of a number of diseases for a given location and of the same disease for several locations, the former to throw light upon variations in immunity as determined by seasons, the latter to determine variations due to geographic position and different physical conditions.

It will be helpful to make a study for a typical American district, and for this I have used New York City. In Fig. 3, we see the seasonal variations for the four diseases, scarlet fever, organic heart disease, pneumonia and disease of the arteries, for 1923 to 1928, inclusive. It will be seen at once that the same general distribution of cases by months is disclosed for all four diseases, with a very marked increase in incidence in the winter and spring months and a corresponding decrease in incidence from June to October, with a sharp rise through November and December.

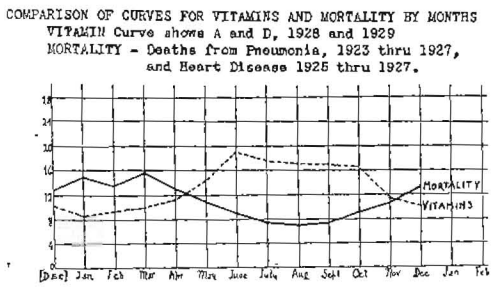
As I have previously stated, we are concerned to analyze differences in the intensities for different places in order to throw light upon the probable causative factors as a detailed method of studying evidences and interrelationships as of cause and effect. It is very difficult to obtain completely comparable data for both factors, since the available vitamin data are limited to those which I have developed during the last four years (most completely, however, for the years 1928 and 1929), and the available mortality data as disclosed for the United States registration area are only obtainable from the Census Bureau up to the end of 1927. I have also used data obtained directly. We are required, therefore, to use curves which are the mean for two or more years in each group and the time covered is not the same in the two groups.

Second Installment

(Reprinted from the DENTAL COSMOS for November 1930.)

IN Fig. 4 will be seen a comparison of the vitamin and mortality curves in which I have presented the total of our figures for vitamin A plus vitamin D by months as the mean of the two years 1928 and 1929. The mortality curve shows deaths from pneumonia for 1923 to 1927 inclusive, and heart disease,

FIG. 4



A study of the relation of the mortality and vitamin curves of the entire registration area of the United States. Note that one is in general the reverse of the other.

1925 to 1929 inclusive. The area covered by the vitamin curve will not be strictly the same as that covered by the mortality curve, nor can the data already available for variations in vitamins in milk-fat be considered to be complete enough to permit of more than general application. (These are not, therefore, a reproduction of the curves for New York City.) It will be seen in this figure that the vitamin curves for Zone IV is low, extending through January, February and March, and begins to rise quite rapidly in April, reaching its peak in June. The June level is not maintained; indeed, it is not reached again in the average of the territory included, though it remains fairly high throughout the summer until October, then drops very rapidly through November, December and January. The mortality curve falls progressively from March until July, maintaining a low level through August and September and rising sharply in October. November, December and January. Except for the depression in the February levels for mortality, we find these curves remarkably smooth and each a reversal of the other. As stated, these curves contain (and therefore are influenced by) the variables of particular districts, such as extreme differences in altitude.

By taking a district centrally located with regard to the population of the United States, such as Ohio, Indiana, Illinois, Michigan and Wisconsin, and noting the similarity in the general characteristics of the curves for mortality of a single disease, such as pneumonia, for the four largest cities, which is seen in Fig. 5 (second from top, third tier) we

have evidence of a common cause from the similarity of the curves. When we apply the vitamin curve, A plus D, for this district to this chart, as shown in the broken line in Fig. 5, we have a striking illustration of the contrast in position of the vitamin curve when compared with the several mortality curves for pneumonia.

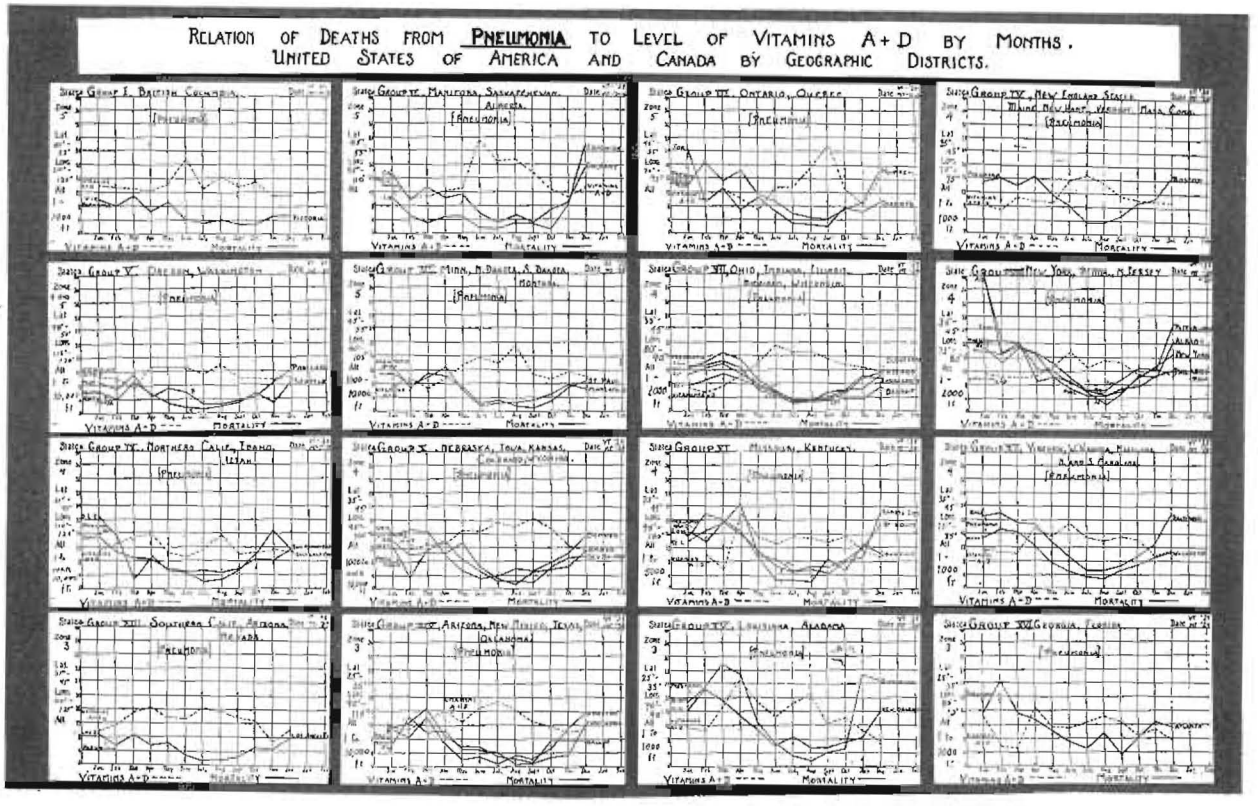
If there is a relationship of cause and effect between these two factors, it should be possible to obtain important data by making a critical comparison of the distribution of the curves in different districts on the basis of latitude, temperature, precipitation, etc., for these factors will combine to determine characteristics of the time when new growth will appear in the grass and thereby produce an increase in the vitamin level. I have accordingly divided the United States and Canada into sixteen districts, each covering many thousand square miles, and related geographically to each other, as these districts exist in the North American continent. These are all shown in Fig. 5. This illustration shows for the sixteen different districts the same data as outlined for Ohio, Indiana, Illinois, Michigan and Wisconsin and their four largest cities. I have selected one or more large cities in each of these sixteen districts and show in this chart the relationship of the curve for pneumonia in the various large cities to the curve showing the level of vitamins A and D combined. No effort has been made to smoothe the curves, which probably should be done or would be accomplished by using a large enough number of years and a large enough number of samples. At the upper right-hand corner of each chart is shown the year for which the vitamin level is recorded and also the year for which mortality curves are presented. In many instances mortality figures could not be obtained for 1929, and curves for earlier years had to be used or composite curves where data for several years were available.

It will be seen at once that, in general, when the vitamin level is low the mortality rate for pneumonia is high, and when the vitamin level rises, the mortality rate descends. It is also of particular interest to note that in those districts where the vitamin level does not rise sharply until June the mortality rate stays up and is relatively late in decreasing. This will be seen to be the case in all of the states and provinces of the northern tier. Similarly, in the southern districts, where the green pasturage has become available at an earlier date, the vitamin has gone up accordingly, which is shown to be associated with an earlier drop in the level of pneumonia incidence, or at least deaths from that cause.

Similarly, I have made a study of the relation of incidence of deaths from heart disease to the curves for vitamin levels as shown in Fig. 6. Many important data are revealed in this chart. It is of very great importance that the death rate from heart disease per unit of population is apparently much greater in the North Atlantic States than in other districts, but the significance of this important characteristic of this illustration is perhaps not greater than the evidence of a lower incidence for the vitamin levels of that district, particularly during the winter and spring.

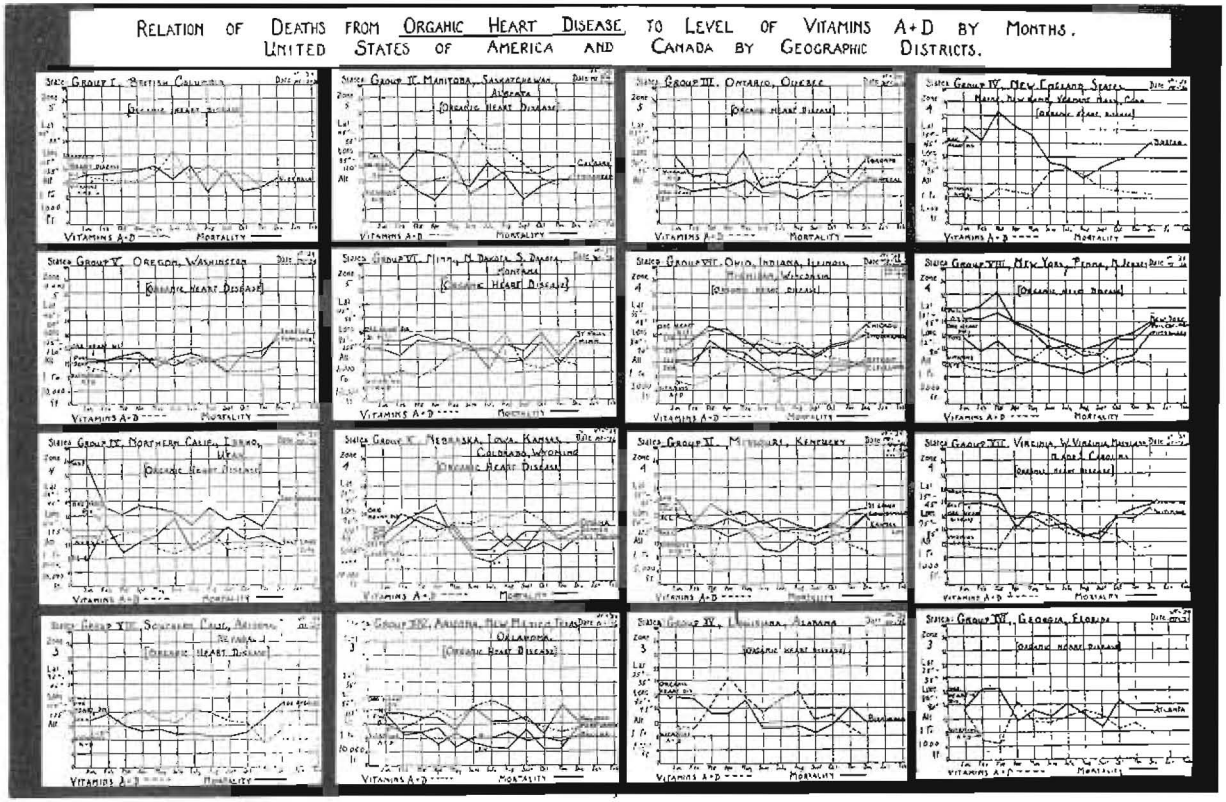
Important discussions have appeared of late regarding the more rapid rate of increase in mortality from heart disease for certain of the states than others. These figures are, for New Hampsbire, 252 per hundred thousand; Vermont, 273; New York, 262; Maine, 240; Penn-

FIG. 5



A comparison of the 1929 combined curves for vitamin A and vitamin D with the curves for deaths from pneumonia for sixteen large districts of the United States and Canada shows not only an apparent relationship, but unique characteristics for different areas.

FIG. 6

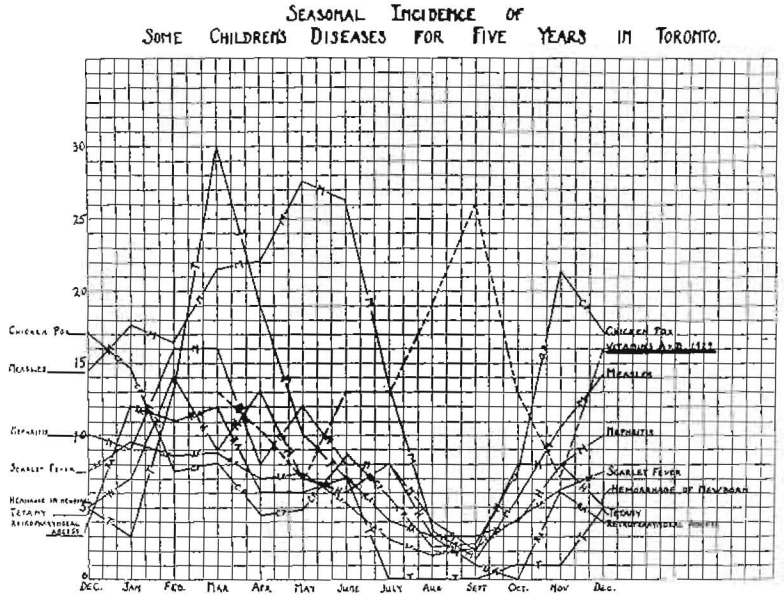


The same evidence of relationship is shown for deaths from organic heart disease as from pnenmonia. These data for vitamin levels are for 1929 and many of the death rate curves are either averages for several years or for the most recent year available.

sylvania, 198, and Illinois, 199 for 1925, whereas the figures for some of the newer states ranged from 82 for North Dakota to 124 for Nebraska.

In order to test further this relationship I have applied the new data to graphical expressions of the incidence of disease in a typical study, for which I have selected Toronto, using recent data presented by Tisdall, Brown and Kelley.[4] In that article is shown the incidence of some children's diseases for five years in

FIG. 7



The average monthly incidences of seven children's diseases are shown in solid lines for five years for the city of Toronto, and reveal a very marked seasonal cycle. The vitamin curve as determined from samples of dairy products is shown in broken line, and is high when the morbidity incidence is low.

that city. I have arranged their data in the order of months, showing the rise and fall in intensity as in the preceding curves. The diseases included are chicken-pox, measles, nephritis, scarlet fever, hemorrhage in newborn, tetany and retropharyngeal abscesses, and these will be seen in Fig. 7. On this same chart I have shown the sum of the levels of the fat-soluble vitamins A and D as disclosed in the determinations made from the samples sent to me every two weeks during the major part of 1929 from about thirty places in Ontario. It will be noted that the rise in the vitamin curve (vitamin A plus vitamin D) is quite clearly the opposite of the morbidity curves.

I shall present data later reporting studies I am making on chemical analyses of grasses, plants and soils for several areas, which space does not permit me to include here. I would, however, make the observation that these data are pointing strongly toward a depletion in the mineral content of the soils and their consequent direct effect upon the vitamin levels of the plants grown on them and used for both animal and human food.

As an important phase of this investigation I have studied the difference in the nutritional effect of three grades of butter as selected on the above chemical basis for the levels of vitamins A and D, when fed to animals on a deficiency diet.

When three kinds of butters were fed to three groups of chickens (all on the same diet, McCollum's 3143) the first group using butter high in both A and D, the second group, a butter high in A and low in D, and the third group, low in both A and D, there was a marked difference in blood chemical studies. The product of whole-blood calcium and whole-blood phosphorus rose in the group receiving butter high in both vitamins A and D from 29.7 (which was the level for all at the beginning) to 32; in the second group it fell to 25 and in the third group to 13. Another series was run to determine the ability of the butters to maintain life. The same three grades of butter were used as in the previous experiment. In nineteen days the deaths in group one were 24 per cent; group two, 52 per cent; group three, 72 per cent.

Another most important observation was obtained by putting all three kinds of butter before the chicks at the same time to test their ability to select the high-vitamin product. In this test, which was run for fifty-seven days, forty chicks had fourteen grams daily of each of the three kinds of butter placed freshly in separate dishes of the same style, and the position of the dishes was changed daily. Of the total of 800 grams of each butter at the end of the test period they had eaten 209 grams of the butter low in both A and D, 287 grams of the butter high in A and low in D, and 415 grams of the butter high in both A and D. In other words, 100 per cent more of the high-vitamin butter was selected and eaten than the butter low in both vitamins A and D, showing the remarkable capacity of the chicken for selecting the most favorable product. No difference could be observed in the flavor or odor by us humans, who sometimes pity the poor animals because of their limited knowledge of nutrition.

CLINICAL DATA ON BETTERMENT PRODUCED BY THE VITAMIN INTAKE

There is another approach to this problem, however, which is even more direct and therefore more important. This consists of the administration of the factors missing in the low-vitamin winter products during the winter and spring, and in the observation of whether there is a marked improvement in the clinical behavior of the individuals receiving those reënforcements as compared with those not receiving such treatment. I have shown in several communications[5,6] that the utilization of calcium and phosphorus is largely dependent upon the presence in the dietary of products that can be obtained from a milk very high in both vitamins A and D and from some cod-liver oils. Many others have presented data supporting the premise that vitamin D is fundamental for proper calcium and phosphorus utilization and that a balance of vitamins is necessary. Space here will not permit more than a brief presentation of this phase.

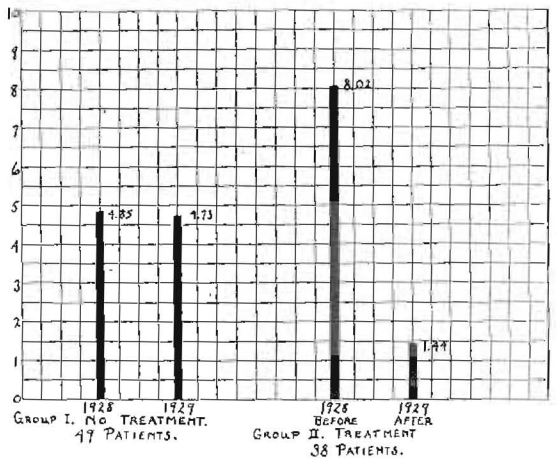
If, as seems abundantly established, the body utilizes the stored calcium and phosphorus and other minerals in the skeleton at a time of shortage in any or all of these minerals from the food or a shortage of essential vitamins, we can readily appreciate that a state of stress would be produced and that the skeleton might readily be depleted in large or small degree; further, that a disturbance not only of normal balance between the minerals and the fluids of the body but also in the functioning of the various organs and tissues, with disturbance of secretions as well as of circulating fluids, would obtain. Such disturbances must of necessity affect anabolism and catabolism and might be expected to produce changes that would be demonstrable in body fluids and tissues. This can readily be established for the hard tissues by means of roentgenograms and in several of the body fluids by chemical and spectroscopic and other methods of analysis. In several hundred successive blood chemical analyses for patients with degenerative processes, imbalances have been shown to be present, and after the administration of suitable vitamins, both the clinical symptoms have been reduced or disappeared and the blood chemical disturbances returned to or toward normal. These will be found

discussed in detail in a much more extended communnication which is nearly ready for pnblication in book form.

During the last twelve years I have been making clinical studies directed toward the prevention of dental caries, having had groups of individuals under stndy each winter and spring and some special cases under treatment throughout the year. This treatment, as now applied, consists in most cases of the administration of from one-half a gram to two grams (usually one and five-tenths grams) of a mixture containing a concentrate of the vitamins obtained from tal disease and other degenerative processes on the basis of my experience; second, to observe whether the administration of the factors that are apparently reduced in quantity in plants and the food products built from them at certain periods and under certain conditions can reënforce and compensate for the absence of these factors in the foods at those seasons when they are of necessity low. We are particularly concerned for dental caries; first, because it is the most universal disease in the world; second, because it is the forerunner of a group of disturbances which follow pulp involve-

FIG. 8

CONTROL OF DENTAL CARIES BY ACTIVATOR ADMINISTRATION.



These data indicate that dental caries is primarily a deficiency disease due to a lack of vitamins, chiefly D, and influenced by low mineral foods.

a very high-vitamin butter with about equal parts (varying according to the conditions) of a very high-vitamin cod-liver oil. The selection of the butter and cod-liver oil is done by means of adopting the colorimetric tests of Carr and Price for vitamin A[7] (which is an extension of the studies of Rosenheim and Drummond) and those of Yoder for vitamin D.[8]

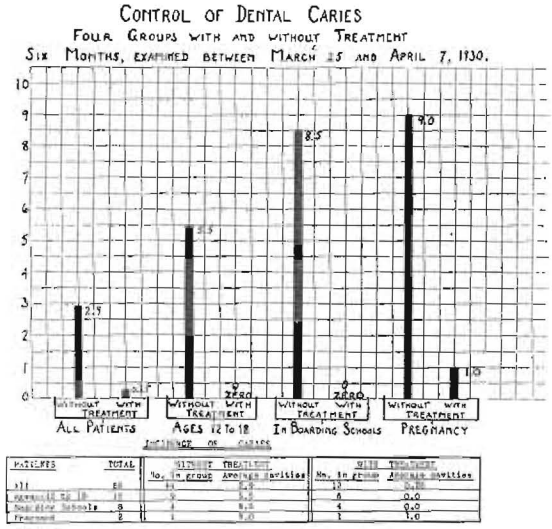
These procedures will be reported in extended detail in the later communication to which I have referred.

The purpose of giving this preparation has been twofold: first, to prevent dement and the associated apical abscess which constitutes a sevère form of focal infection; third, because it is readily demonstrable that dental caries has great significance as an indication of disturbed calcium and phosphorus metabolism, it generally being associated with the physical state in which calcium or phosphorns, or both, are being utilized hy the body more rapidly than they can be taken from the food, attended by skeletal decaleification. It therefore has great importance as a symptom.

As one of the meaus for investigating this phase of the problem in detail, I

show in Fig. 8 the result of studies carried through 1928 and 1929 on two groups of patients, one receiving preventive treatment during the winter and spring and the other not receiving preventive treatment. In Group I, receiving no treatment, there were forty-nine patients and these had an average for 1928 of 4.8 cavities per individual, and in 1929, 4.7. In Group II, there were thirty-eight patients who had marked evidence of calcium and phosphorus metabolism disturbance, and had the caries in four groups with and without treatment for the past six months. Examination was made in the two weeks preceding April 7, 1930. Out of the fifty-six patients for whom I made the routine quarterly or half-yearly examinations, forty-four were not receiving treatment, and in this group the average number of cavities per person was 2.9. Twelve were receiving the vitamin capsules, and the average number of cavities per person was 0.25. The difference in incidence, it will be noted, was over tenfold. Of this

FIG. 9



The number of cavities per individual in each of two groups, those with and those without treatment, are shown by the height of the column for each of the four classes. Where no cavities were found it is shown by a zero which occurred in the two center classes, in the group taking treatment.

most severe dental caries. During 1928, the individuals of this group, when not on treatment, had an average of 8.2 cavities per individual and in 1929, after treatment, 1.4 cavities. It was of course impossible to control all the variable factors. However, the difference is too great to be readily accounted for without consideration of the treatment. Together with the marked reduction in dental caries there was a very marked improvement in physical well-being.

Many groups are under study at this time, some of which are shown in Fig. 9, which discloses the reduction of dental group there were fifteen between the ages of twelve and eighteen, nine of whom did not receive treatment and had 5.5 cavities per individual. Six were receiving treatment, and not a single cavity was found in any one of the six.

The method of study includes not only careful instrumental examination of every available surface of the teeth, but roentgenographic studies of at least molars and bicuspids, usually by bite-wing roentgenograms. Eight of the people between twelve and eighteen were in preparatory schools and colleges, and had been living in dormitories. Of these,

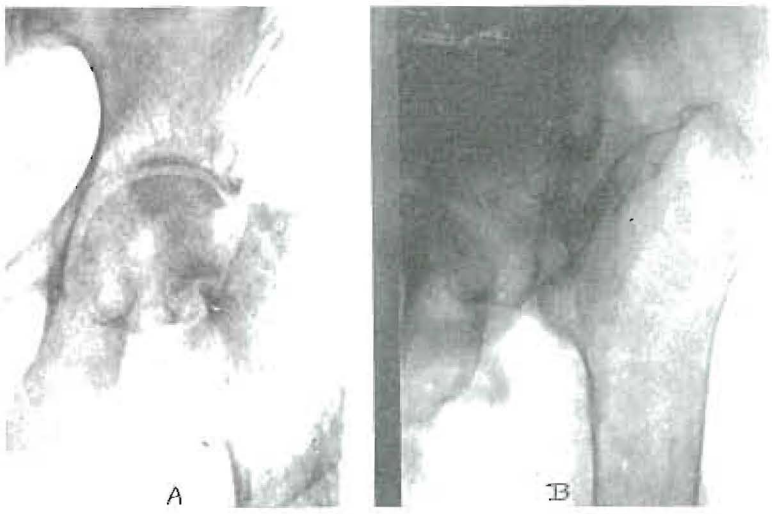
four were not receiving treatment and had an average of 8.5 cavities per person. The other four were receiving treatment and I could not find a single cavity in any one. During these two weeks two cases of pregnancy had their routine examination, one of whom was receiving treatment and the other not. The one without treatment was in the sixth month and had nine cavities. The one receiving treatment was in the ninth month and had one cavity. The physical well-being of all of the individuals receiving treatment was decidedly above that of the group not receiving treatment. Included in the group in boarding schools were two boys, brothers, ages thirteen and fifteen, one receiving treatment and the other not. The one not receiving treatment had four cavities and the one who received treatment had none. This is only a very small part of the data already developed in these researches and typical of the results being obtained.

One of the most striking illustrations of the demineralization of the body to meet the imperative needs of the body tissues in the maintenance of life is disclosed in the progressive wasting of the skeleton. This will be found in progressive decalcification, with the result of the weakening of the skeleton. I have before me, for example, the roentgenograms of a boy fourteen years of age who has had thirty-six fractures. I have recently made blood chemical studies of a girl who, a short time ago, had two ribs fractured, the second one fracturing at night while changing her position in bed and the former with very little more strain. This condition, however, is most frequently found in elderly people, whose bones sometimes break from very slight strain, and these unfortunate individuals usually have great difficulty in reëstablishing a union of the fracture. This difficulty of the healing of broken bones, however, is not limited to elderly people. This seems to be a process which might be expressed as burning the furniture and is apparently occasioned by an inadequate assimilation of calcium and phosphorus and the inability to utilize it, probably chiefly the former. While this seems to be due in some cases, in part at least, to an inadequate supply of these chemicals in the food, it is probably more often produced by an inadequacy of the proper vitamins for utilizing even the minerals that are available in the food. This type of case therefore lends itself to the studies with which we are concerned in this problem.

A typical case will be seen in Fig. 10, in which we see an intracapsular fracture of the neck of the femur, ununited and without evidence of callus after nine months, considerable of which time was spent in a cast. This patient was a woman, seventy-four years of age, who had the additional embarrassment of knowing that her mother died at seventy years of age, one year after she had broken her hip, and this patient could readily trace the similarity of the symptoms. When solicited for assistance by her physician, Dr. J. D. Holston of Massillon, Ohio, I provided containers with special chemicals and had the blood sent for study. The blood showed distinct imbalances; for example, the product of serum calcium and serum phosphorus, instead of being 40 or above, was at 26. It is important to note in the roentgenograms the marked absence of cortical layer, not only on the femur but also on the pelvic bones. The other femur showed the same condition which no doubt obtained in all the bones of her body. The change from the condition at A, nine months after the fracture, to the condition at B, three months later, was produced without greatly changing the main diet. She had the addition of capsules containing a concentrate of vitamins from a high-vitamin butter mixed with about equal parts of a very high-vitamin cod-liver oil, both determined on the basis of chemical tests. It is very important to note that in three months' time the blood chemical condition changed in a very marked degree. The serum calcium rose from 9.8 to 11. The inorganic phosphorus from 2.6 to 4. The product of these two factors increased from 26 to 45. The marked change in the blood was followed by very marked physical improvement and general roentgenographic evidence of bone deposition. Note

particularly the rebuilding of the cortical layer on the shaft of the femur and on all surfaces of the bones, including the fractured surfaces. The case went rapidly to apparent complete union and the patient has had no important setbacks. This treatment and healing process began just three years ago and the woman is walking about and using the limb with splendid comfort and efficiency. Last summer she had a fall with sufficient strain to injure the ligaments of that knee, but the hip withstood the strain without injury. She has continued to take the capsules and is maintaining excellent health. This case is typical of several in which I have been asked to coöperate with the physicians in charge, and in which there was evidence that this treatment had aided greatly in bringing about the union of ununited fracture.

FIG. 10

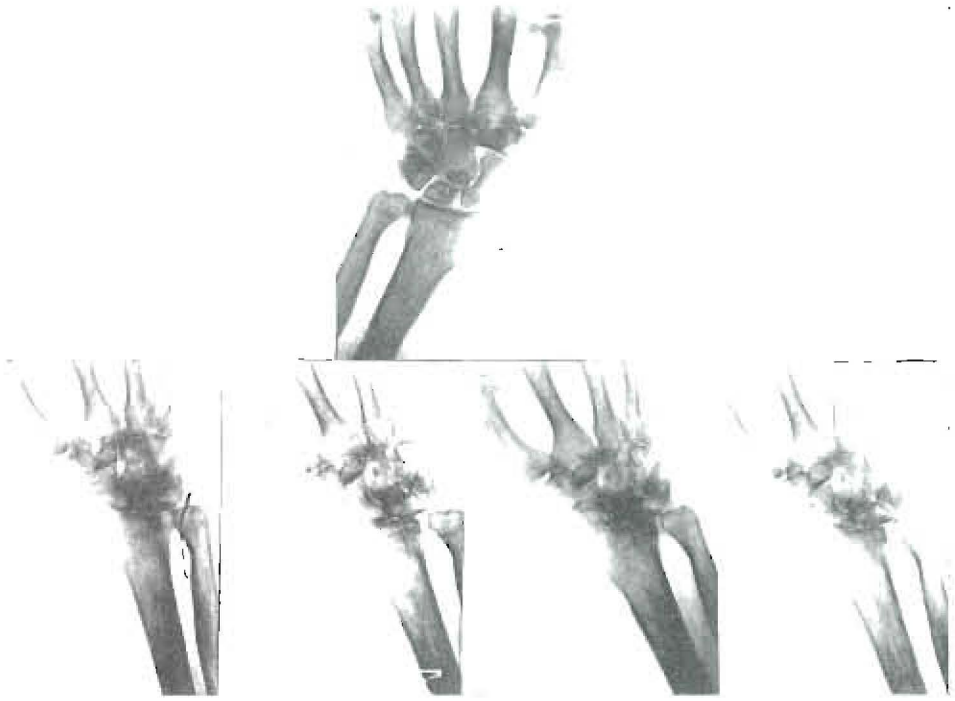


The healing of an ununited fracture of nine months' standing, as shown after three months' treatment. Note the additions to the cortical layer of practically all surfaces. Final union was complete.

Another type of case which has much significance and which is typical of a considerable number is shown in Fig. 11, in which an acutely painful and progressive arthritis of the right hand is shown roentgenographically to have undergone a very marked change since the time the intake of vitamins was increased as outlined above. The condition had previously become progressively worse through sixteen years. This man had originally been a painter and had developed symptoms of lead poisoning, for which and to remove focal infection all of his teeth had been extracted. Several joints were swollen and painful and he walked with both pain and difficulty. The upper picture shows the normal left hand. The lower series show the progressive improvement through seven months as roentgenographically recorded. Clinically, the swelling receded, pain subsided and the stiff hand became pliable and, whereas handling it produced great pain at the beginning, it became in six months only slightly more sensitive than the normal hand. The treatment in this case was similar to that of the last. Very marked blood chemical changes were noted. The calcium per 100 cc. of serum, for example, increased from 7.3 to 10 milligrams, but the principal change was found in the non-diffusible calcium, which increased from 1.9 to 5.1.

The inorganic phosphorus of the serum remained approximately the same, the reading being 3.4 for the first test and 3.3 for the second. There was an increase in the blood proteins of 11 per cent. Space does not permit of presenting here typical cases illustrating the changes produced in many other phases of disturbed growth and function and various phases of degenerations.

FIG. 11



Shows the progressive change in the resolution of an acute arthritis of the right wrist associated with lead poisoning of a painter. The normal left is shown above as a control.

Since there is so much evidence that physical changes as degenerative diseases as well as acute infections occur much more frequently in the winter and early spring than in the summer and early fall in the north temperate zone, and since so much information has been provided by many workers in many countries indicating that dental focal infections, as well as other focal infections, particularly those from tonsils, are contributing factors to degenerative processes; further, since so much evidence is available indicating that the vitamin intake, particularly vitamin A and associated activators, has much to do with the resistance of the body to infection or the maintenance of immunity, we see at once at least one explanation why individuals may carry dental and other focal infections without apparent injury for a considerable time and then more or less suddenly, often following influenza or other acute infection, develop degenerative processes in other parts of the body, from which a streptococcus having many physical and biologic qualities resembling those in the focus may be developed. This will also explain why individuals who do not carry a source of infection at the time their defensive mechanism has been depleted through a lowering of the vit-

amin intake may not break in some tissue, because no organism is available in the system with special attacking power and elective localization qualities for striking such a blow. This stresses the great need that individuals shall be kept free from sources of infection, particularly those carrying organisms with elective localization qualities.

I cannot discuss in this presentation the fundamental importance that our bodies shall be provided with all the necessary activators in appropriate or balanced quantities. Of course the other known vitamins, B1 (F), B2 (G), C and E are all fundamental for life and health, and must be provided. All of these would be provided in milk of highest efficiency. Investigations are in progress and several have been reported showing that seasonal variations in vitamins B and C frequently occur and are major problems in many countries.[9]

Since, however, these vitamins are much more readily provided because of their occurrence in other foods, they do not become of so great concern as the fat-soluble activators that are essential for mineral utilization, particularly of calcium and phosphorus. While these include vitamin D, the available data suggest that there are other activators not yet identified. Vitamin A, which plays so important a part in the functioning of epithelial tissues, is apparently also essential for the tissues and structure of the eye, particularly the retina, and for structures of the nervous system and the membranes of the respiratory tract. This vitamin and associated activators is also essential for the maintenance of immunity against infection.

Administration of the concentrates for reinforcing vitamins A and D and associated activators is always given with direction for the reinforcement of the diet to supply vitamins B1 (F), B2 (G), C and E.

SUMMARY

(1) A brief review has been made of the progressively changing viewpoint with regard to the nature and cause of the so-called degenerative diseases. This has included a critical consideration of the data supporting the present conviction that has largely been built up on both clinical and laboratory data indicating that focal infections, particularly dental focal infections, may and often do play an important part as etiological factors in organ and tissue degenerations.

(2) Data have been presented in condensed form indicating the results obtained by Rosenow, Haden and myself from the inoculation of animals with cultures from teeth of patients suffering from degenerative processes in special organs and tissues. These have shown a remarkable constancy in the results of all three of these authors, who have made very extensive studies in this field. These data reveal a marked increase in the number of animal localizations in the same tissue as that of the patient from whom the dental culture was obtained. This quality is sometimes spoken of as elective localization, or specific affinity. I have presented data supporting the view that the individual carrying the infected and diseased organ provides a pabulum and environment for the organism growing in the dental focus which modifies the organism in such a way that it develops a particular attacking power for that organ or tissue which is affected in the patient's body.

(3) A critical comparative study has been made of the so-called radiographically negative teeth with the radiographically positive teeth. I have presented data indicating that the results of an extended series of studies by both Haden and myself have shown that the localizations in animals inoculated with cultures from each of these two types of teeth are approximately as severe in one type as in the other with regard to total general localizations. In my own series the ratio of general localizations was one-third greater in the radiographically negative teeth than in the radiographically positive teeth. When a study of these two types of teeth is made on the basis of the tendency to reprodnce in animals the lesion from which the patient was suffering, the localizations were twice as

great in the radiographically negative teeth as in the radiographically positive. A large percentage of the teeth used in these studies included those with root fillings which had been placed as well as the superb skill of members of our profession had been able to accomplish, and yet seemed to compel the conviction that the only really safe root filling for a tooth is a healthy pulp. This strongly enforces the conviction that the emphasis must change from repair to prevention of dental caries and thus prevent pulp involvements.

(4) Data have been presented which I have interpreted to indicate that dental caries is, in large part, a nutritional deficiency disease and should be treated as a constitutional as well as a local problem. New data have been presented indicating seasonal tides in both the degenerative diseases and the level of certain of the activators in foods. These data show factors that are in opposite phase, strongly suggesting a relationship both of common effects of common causes and that of cause and effect. The opposing relationship has been shown to obtain in a general way in each of sixteen districts when the United States and Canada are divided up into sixteen divisions, and applies to acute infections such as pneumonia, chronic degenerations such as heart disease, and nutritional diseases, including dental caries.

(5) Emphasis has been placed upon the evidence that life-giving activators which are provided directly and indirectly from plant life undergo a variation in the food intake at different months of the year. A typical food, the only one which can provide all the qualities essential for life and growth in infants, namely, milk and its products, has been used to illustrate the effect of plant food activators both directly and through storage in the animal foods upon animal life.

(6) As illustrations of practical applications some clinical data have been presented showing the marked reduction or lessening of severity of some of the degenerative processes through the administration of the activators found to be present in some foods in varying amounts. These have included evidence of (a) a marked reduction in the incidence of dental caries; (b) a checking of progressive decalcification and return of calcification with union of ununited fracture; (c) a marked reduction in inflammatory irritation associated in a case of arthritis, with evidence of a marked change toward normality.

(7) These data are presented in support of a new view that degenerative diseases, including those of the oral cavity, are in large part related to, if not primarily caused by a deficiency in a group of activators which are formed in plants and stored by animals in milk and some tissues without which human life cannot readily be maintained in normality. By the administration of these deficient factors it may be possible to greatly improve the sum total of human efficiency, freedom from disease, both from acute infections and from degenerative processes, and obtain a marked increase in physical well-being.

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