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**Nutrition in the aged**

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NUTRITION IN THE AGED

Donald H. Penner

Senior Thesis presented to the College of Medicine,
University of Nebraska
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NUTRITION IN THE AGED

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INTRODUCTION

Forty years ago marked the entrance of another specialty to the field of medicine. The medical world had been slow to accept the plea of those who had labored long and hard to see that day. It had long been their belief that infancy and childhood were definitely different from the other stages of life and that these differences were sufficient to demand special attention in regard to medical care. From this turn in medical progress, we have acquired a new problem today. This interest in infancy and childhood, marked by considerable research, has left the world with a population much changed as far as age is concerned. The huge child mortality rate which was so common in the last part of the nineteenth and prevalent during the beginning of the twentieth century is no longer in existence. The percentage of people in the old age group is becoming increasingly larger. (See Table 2)

The decade before had seen revolutionary discoveries destined to change the whole aspect of medicine. From 1880 to 1890, through the ingenious pioneering of Lord Lister, the nature of infection became known, and following in its wake, the treatment thereof. Still, progress did not stop with the
control of infection. Pasteur went further than Lister, for he conceived the idea that bacteria were the cause of the various febrile diseases transmitted from person to person. His work resulted in the development of vaccines and in the prophylactic virus against rabies. This marked the beginning of the field of preventative medicine. The following years saw great development in vaccines and antitoxins. Diphtheria, Small Pox, Typhoid, Tetanus, and others are no longer the scourge that they had previously been. Also in the field of preventative medicine came the knowledge of the cause and prevention of Yellow Fever, Malaria, Plague, etc. (21) This has wrought great changes in the field of medicine. Conditions have changed until now the medical world finds itself at the brink of a new era, unlike previous eras in medicine. It has not been ushered in by revealing discoveries. It has gradually forced itself upon us. So slow has been its' development that even yet the entire medical world is not aware of it. Since the second decade of this century, however, farsighted men have seen its advance and have sought combined medical efforts to meet this new, increasingly vital problem.
Since its' inauguration by Nascher, many have worked toward the end that care for the aged might become a special branch of medicine, but as in Pediatrics, the medical world is slow to accept.

The following figures best portray what changes have been brought about by the discoveries of infection, vaccines, antitoxins, and other measures of preventative medicine. Table 1 shows the regression of mortality rate from several prominent causes of deaths due largely to these measures. Table 2 shows the marked elevation in life expectancy that resulted. Undoubtedly, preventive medicine played a large role and, directly or indirectly, accounts considerably for the rise in life expectancy and decreased mortality rate. Yet it must not be forgotten that the better understanding of medical problems of infancy and childhood as acquired by the Pediatrician has had a definite bearing on these figures.

The first column shows the actual deaths in 1935. The second column shows the expected number of deaths as calculated from the mortality rate in 1900. The third column shows the difference or the number of lives saved by medical improvements during this time.
Table 1. Regression in Mortality from Several Prominent Causes of Death (1900-1935)

<table>
<thead>
<tr>
<th>Causes of Death</th>
<th>Deaths in 1935</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
</tr>
<tr>
<td>All Causes</td>
<td>1,207,359</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>51,269</td>
</tr>
<tr>
<td>Influenza and Pneumonia</td>
<td>110,191</td>
</tr>
<tr>
<td>Diarrhea and Enteritis</td>
<td>17,018</td>
</tr>
<tr>
<td>Measles</td>
<td>3,435</td>
</tr>
<tr>
<td>Scarlet Fever</td>
<td>2,646</td>
</tr>
<tr>
<td>Whooping Cough</td>
<td>3,673</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>3,428</td>
</tr>
<tr>
<td>Typhoid</td>
<td>2,386</td>
</tr>
<tr>
<td>Nephritis</td>
<td>89,240</td>
</tr>
<tr>
<td>Cerebral Accident</td>
<td>85,732</td>
</tr>
<tr>
<td>Puerperal State</td>
<td>10,018</td>
</tr>
</tbody>
</table>

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Table 2. Expectation of Life at Birth Among Total White Persons by Sex for the United States (1900-1936)

<table>
<thead>
<tr>
<th>Year</th>
<th>Expectation of Life at Birth in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Persons</td>
</tr>
<tr>
<td>1936</td>
<td>60.91</td>
</tr>
<tr>
<td>1935</td>
<td>60.37</td>
</tr>
<tr>
<td>1934</td>
<td>60.79</td>
</tr>
<tr>
<td>1933</td>
<td>61.26</td>
</tr>
<tr>
<td>1932</td>
<td>61.07</td>
</tr>
<tr>
<td>1931</td>
<td>60.26</td>
</tr>
<tr>
<td>1929-1931</td>
<td>59.57</td>
</tr>
<tr>
<td>1919-1920</td>
<td>55.33</td>
</tr>
<tr>
<td>1910</td>
<td>51.49</td>
</tr>
<tr>
<td>1901</td>
<td>49.24</td>
</tr>
</tbody>
</table>

Tuohy: Wisconsin Medical Journal 39:353 May 1940
People are living to an older age. Patients in the old age group are filling the offices of the practitioner and with this change in the age group, there is also a change in the diseased conditions presented.

Table 3. Increase of Mortality (1900-1935) From Several Prominent Causes of Death

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Deaths in 1935</th>
<th>Actual</th>
<th>Expected by 1900</th>
<th>Lives Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic heart disease</td>
<td></td>
<td>212,167</td>
<td>153,584</td>
<td>55,583</td>
</tr>
<tr>
<td>Carcinoma</td>
<td></td>
<td>129,124</td>
<td>86,193</td>
<td>43,021</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td>26,606</td>
<td>14,301</td>
<td>12,305</td>
</tr>
<tr>
<td>External causes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>including suicide</td>
<td></td>
<td>94,851</td>
<td>84,688</td>
<td>10,683</td>
</tr>
</tbody>
</table>

Tuohy: Wisconsin Medical Journal 39:353 May 1940

Heart disease, chronic nephritis, carcinoma, etc. are more and more frequently encountered. Diphtheria, Typhoid, Tuberculosis, and other infections are becoming more scarce. (See Tables 3 and 4.)
Table 4. Death Rates per 100,000 of Population in United States in 1937 by Specific Cause Arranged in Numerical Importance

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Death rate per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases of heart</td>
<td>228.</td>
</tr>
<tr>
<td>Carcinoma and other malignant tumors</td>
<td>102.2</td>
</tr>
<tr>
<td>Influenza and pneumonia</td>
<td>95.6</td>
</tr>
<tr>
<td>Nephritis and other kidney diseases</td>
<td>85.7</td>
</tr>
<tr>
<td>Cerebral hemorrhage</td>
<td>84.</td>
</tr>
<tr>
<td>Tuberculosis in all forms</td>
<td>59.5</td>
</tr>
<tr>
<td>Diseases of earlyancy and malformations</td>
<td>50.6</td>
</tr>
<tr>
<td>Auto accidents</td>
<td>24.7</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>21.3</td>
</tr>
<tr>
<td>Diarrhea and enteritis</td>
<td>17.3</td>
</tr>
<tr>
<td>Arteriosclerosis</td>
<td>16.8</td>
</tr>
<tr>
<td>Suicide</td>
<td>15.7</td>
</tr>
<tr>
<td>Tuohy: Wisconsin Medical Journal 39:353 May 1940</td>
<td></td>
</tr>
</tbody>
</table>

It will be seen that the conditions resulting in death to the greatest number are those due to aging of the body and to nonpreventable organic defects. (46)

Since the turn of the century, still another vast field of medical endeavor has been opened. Marked by the discovery of vitamins and their influence in human well-being, this field shows great possibilities. That food has been associated with a man's well-being goes back far into history. Stories of gout and rich living are quite prevalent in literature. The story of the boy and the green apple is well known. A number of religions prescribe many foods. Hindus and the Seventh Day Adventists are vegetarians. Pork is forbidden to
the Mohammedan and Hebrew. Good Catholics do not eat meat on Friday. All this indicates a belief that human well-being can be promoted through dietary restrictions. Only now, however, is scientific information available. Application of this information promises to be one of its greatest difficulties. In the past, the extraordinary success in liberating man from the pestilential diseases has been achieved largely in the field of environmental sanitation. No great change has been required in man's habits. Swamps have been cleared, to rid man of Malaria and Yellow Fever. Vaccinations have rid man of Smallpox, Typhoid, and Diphtheria. Great as these victories have been, the knowledge for far greater conquests is already available. The application, however, depends upon personal effort and the question is, can this be brought about on a sufficiently large scale to equal or excel former achievements? To induce man to change his personal habits requires extraordinary effort. (22)

It has been pointed out that medicine is at the present, entering upon two new fields of endeavour, Geriatrics and Nutrition. It is believed that advances
in these two branches of medicine will proceed hand in hand, that one will directly augment the other and vice versa. That any advance in nutrition will lengthen life is the only logical conclusion to draw, otherwise its very purpose is defeated. It is the design of this paper to show that nutrition is a definite, distinct, and very great problem confronted in Geriatrics. It is now realized that if nutrition is to have its full effect on the aged, its' principles must be applied in infancy and childhood. That this is the ultimate goal, and the only answer, is evident. However, at present, we are confronted with many old people in whom this cannot be achieved. It is with special reference to these that the subject is approached.
The history of the study of pathological changes in the aged, dates back much farther than the acceptance of Geriatrics, as a specialized form of medicine, would indicate. Numerous writers have commented upon such changes, but it has been only within recent years, comparatively speaking, that condensation and classification of this realm of material has presented itself. Authors have approached this subject from two viewpoints: First, those, mostly of the past, but also of the present, who philosophized and concluded with little statistical exactness, and second, those who deal with scientific facts. Present writings would indicate that in the future, these two viewpoints will be blended together into the solution.

Hippocrates made many observations on old age. He noted that "Old people, on the whole, have fewer complaints than the young, but those chronic diseases which do befall them, generally never leave them." He also noted that "Persons who are naturally fat, are apt to die earlier than those who are slender." He listed the diseases, or ailments, of aged as; "to old people, dyspnea, catarrh accompanied by cough,
dysuria, pains in the joints, nephritis, vertigo, apoplexy, cæcæxia, pains in the whole body, insomnolency, deflexions of the bowels, of the eyes, and the nose, dimness of vision, and dullness of hearing."(23)

Egyptian civilization, in practicing the art of lengthening life routinely used emetics and sudorifics. As a rule, two emetics were taken each month, and the stress on sudorifics was reflected in their greeting, "How do you perspire?"

Respect and desire for a long life, is encountered in numerous places in the bible. From Genesis 5: In the lineage of the generations of Adam given there, ten men are named, eight of whom lived beyond the age of nine-hundred years. Methuselah, the oldest, lived to the age of nine-hundred and sixty-nine years.

Stories of human culture, which existed in the old uncivilized areas, relate definite attitudes toward the aged. In the societies where self-preservation was fundamental, the aged were sacrificed in times of stress. The impression, that when an individual's physical prowess was gone he was longer useful, was so strong that in certain tribes self-destruction
became customary. However, there were societies in which the counsel of the elder members was much respected and they were cared for, for this very purpose. The Spartans were such a society. Their city counsel, the Gerousea, was composed of twenty-eight men past the age of sixty. The Greeks, on the other hand viewed old age as dismal and oppressive. Many of their old people, were poisoned, even by their hand. (19)

In Rome, the counsel of the older leaders was sought. The senate was composed mostly of these older leaders, similar to the Spartans, and a great city grew in which was created a protection for the aged. Later, numerous theories arose, as possible explanations for the age attained by these famous old Romans. In 1744, J. H. Cæbansen hypothesized that Hermippus must have been an instructor in a school for young virgins and thereby received the benefits of their life lengthening exhalations. The belief that the respirations of the young were beneficial and of definite value in attaining old age, has been quite popular throughout history. It is said that King David tried it, and it is known that The physician Boerhaave prescribed "sleeping between
two young people," to a patient of his. (19)

Roger Bacon, mathematician and physician of the Thirteenth Century, wrote "The Cure of Old Age and Preservation of Youth." This was translated from Latin into English by Richard Brown in 1683. In this text, the signs, symptoms and treatment of many disease processes prevalent in old age were noted. However, Bacon wrote in an unreceptive time, and although his work really marks the onset of the modern attitude toward Geriatrics, it was not until 1724, when Sir John Floyer released his writings on this subject, that it received worthy attention and consideration. Floyer had taken much from Bacon's text, but unlike Bacon, his work came at a time much more receptive, and as a result, Floyer's writings are usually considered the beginning of modern Geriatrics. Floyer expanded on the thesis of hot and cold bathing and moderation in all things. (18)

The conception of moderation in all things had been the main theme of Cornaro's writings of the sixteenth century—"Sure and Certain Methods of attaining a Long and Healthy Life—with Means of Correcting a Bad Constitution." He warned that "those
who would not partake of this divine medicine, would suffer from degenerative ailments." His stand is clearly seen when he writes, "I have observed that it is custom which has given rise to two very dangerous evils within a little time in Italy; the first, I reckon to be flattery and ceremonies; and the second, intemperance both in eating and drinking....and against the latter, I declare open war, as being the most destructive of health and the greatest enemy it has." Cornaro wrote when he was close to one-hundred years old. His written conclusions were drawn from his own personal experiences, for even though his health was broken when he was a young man, he lived to a ripe old age. (11)

In the last portion of the eighteenth century, a German philosopher and physician by the name of Hufeland, wrote his book, "The Art of Prolonging Life." It is interesting to note that he tells of the age old method of instilling vigor and youth into old bodies by contact with young individuals. (19)

The middle of the nineteenth century marked the beginning of a new approach to Geriatrics. Up to this time, literature had acknowledged the aging body, much as a worn out machine functioning in the same manner as
it had during youth, but now, not so effective because of its worn out mechanism. Philosophy, rather than Physiology had been the approach. Now the approach shifted to the idea that in old age there was a Physiology distinct from that of the other eras of the living body. In the writing of J. M. Charcot, 1867, this new approach is definitely established, and the transition is described by Charcot, in his introduction. "In our day a profound, and radical revolution has occurred in medicine......It would be going quite too far if we were to say that an unfathomable abyss opened just at that period and separated the medicine of ancient from that of modern times. No traditional ties are not sundered; the labor of times gone by is not lost. Still, it must be confessed that new horizons have opened to us and that the views of modern science are from a standpoint which has risen as it has altered." (9)

At the turn of the century, attention had been drawn to the question as to why a man should grow old. Numerous theories were offered as possible explanations. C. S. Minot, in 1906, presented his theory of aging. He states, "The material I have to present falls naturally..."
into two divisions, and we shall take up first the consideration of certain laws of growth; second, the study of certain changes in cells and tissues during development. I shall then try to show that these two sets of phenomena are intimately correlated and that their correlation affords us a conception of the essential changes, the final result of which is old age. In other words, I shall offer to you a cytological explanation of senescence." (32) Metchnikoff followed the next year with his conception based on auto-intoxication. A. Lorand, during this time, published his views, in which he placed the whole endocrine system as the key to the solution. Lorand followed the lead of Sir Victor Horsley, who in 1885, had presented the thyroid gland as the solution. (19) Nascher and Warthin presented ten and eleven theories respectively that had been advanced as an answer. (35) (49)

Almost simultaneous with this search for the answer to the question why, and perhaps springing from it as a method to the answer, came a series of works that called for the medical world to accept Geriatrics as a specialized form of medicine. Up until this time,
the word Geriatrics had not appeared in the literature. In 1909, I. L. Nascher applied Geriatrics to his masterpiece. Nascher, that old age should be considered entirely apart from maturity and suggested that it be studied as a special branch of medicine to which he applied the term Geriatrics. The term is derived from the Greek, geron, old man, and iatrihas, medical treatment. Nascher writes, "Sudel's monograph gave hints and suggestions which could be used as themes for investigation and development but there was still lacking something upon which the superstructure of a new branch of medicine could be built. This was furnished fifteen years later in an apparently trivial remark made by the physician of a Home for the Aged near Vienna. He said, "We deal with the aged inmates as aged persons just as the Peiastirist deals with children....Senility is a physiologic entity like childhood; not a pathological state of maturity......Diseases in senility are pathological conditions in a normally degenerating body; no diseases such as occur in maturity." Upon these cardinal principles was erected the new branch of medicine. (35)
Jacobi, the father of Pediatrics, was keenly interested in Geriatrics, although his writings were largely concerned with Pediatrics. He believed that the medical profession would be slow to accept Geriatrics as a specialty just as it had been slow to accept Pediatrics. (44)

Thewlis releases a book, "Geriatrics" in 1919, which was a definite advancement over Nascher's text. In this book, Thewlis placed undue emphasis on the kidneys much as Floyer had on baths and Cornaro on temperance. However, this work has a definite place in the procession. Thewlis has released the third edition to this text just a few months ago, and although time is not sufficient to allow for a true and general evaluation of this work, it appears that it is another stepping stone leading on. (44)

Two other authors, who wrote in this last period, deserve recognition. In 1925, L. B. Williams, published his work which deals with endocrinology and auto-intoxication as factors in old age. (50) Five years later, A. S. Warthin wrote "Old Age" in which it is shown that senescence is a natural involutionary process. (49) The minor changes are shown to be for
the good of the individual; the major changes including death for the good of the species.

And so we have come from the ancient to the modern, from philosophy to physiology. Although the road has been long, the goal has not yet been reached. Present thought is that advance is hindered by the lack of research, and research in turn is hindered by the lack of acceptance of Geriatrics as a speciality. It has been a quarter of a century since it was suggested that Geriatrics become a specialized branch of medicine and although many have been added to the ranks of those in favor, Geriatrics is still without official recognition.
ANATOMICAL AND PHYSIOLOGICAL CHANGES IN SENILITY

One of the fundamental principles upon which Geriatrics is based is that disease in senescence in a normally degenerating organ or tissue is not a disease such as is found in maturity, that degenerating processes normal to senescence definitely change the physiology of the aged from that of the mature. For this reason it becomes us to devote some time in the discussion of these degenerative changes, their effect on the function of the organ, and hence the length of life. It is interesting to note that H. S. Simms, in a clever but complicated manner, found a statistical correlation between senile debility and senile death rate. (42) This suggests that the progressive debility in old age is caused by an alteration of the same functions which controls the death rate. He therefore believes, "It is to be expected that any mitigation of these alterations will prolong the vigor of youth as well as delay death in old age. This would mean a prolonged middle life with a relatively smaller portion of life spent in dependency." It is with this hope in mind that research today continues in this field.

Anatomic changes, called senescent degenerations,
occur in every organ and tissue of the body. The degenerations peculiar to the period of involution, consists of a combination of organ and tissue changes shown histologically by well defined tissue alterations and clinically by descending function curves. These degenerations are normal to old age and are of two types, primary and secondary. The primary are, numerical atrophy, quantitative atrophy, shrinking, condensation of the inter-cellular substance, and vascular changes. The secondary changes occur in every organ of the body, and are largely due to diminished circulation, general atrophy and to conditions of stasis. The degenerative tissue is either not repaired at all or is replaced by tissue of a different character. In every case where the waste is repaired by other tissue, the new tissue is of a lower order, requiring less blood and is incapable of doing the work of the wasted tissue. (44)(13)

In the gastro-intestinal tract, there is an atrophy of the muscular fibers with a consequent dilatation of the organs. The glands imbedded in the walls of the intestines and stomach undergo atrophy. Muscles of the tongue likewise undergo atrophy and
become atonic. The sense of smell becomes weak in the aged and occasionally there may be perversions of smell, or it may be entirely lost. When the sense of smell is disturbed, there is usually evidence of disturbances in taste also. These have a definite influence on the psychic reflexes stimulating gastrointestinal function. The teeth which in the average case last to the sixty-fifth year, are also involved in senescence. Constantly one encounters old individuals with few remaining teeth. The grinding surfaces are not matched, and as a result, mastication is poor. Many sets of false dentures are found which fit poorly and offer little as aid to mastication.

Another function distorted by these changes is the secretion of enzymes. Jacob Meyer and his co-workers found a definite decrease in the amount of ptyalin in the human saliva in old people. His studies were made on a group of twenty-seven males and females between the ages of sixty-nine and one-hundred years. The average age was eighty years. The figures obtained were compared with those obtained from the control group of young subjects.
It was found that the "fasting" saliva of the old group contained .303 units of ptyalin as compared to 10.15 units in the young group. When stimulated by gum, the ptyalin in the old group was .28 units, while in the young group it was 8.2 units. The amount of saliva was also found to be diminished in the old group by nearly one-third. This change was thought to be due to the atrophy of the ptyalin secreting gland cells. (30) It is therefore seen that old people have a deficiency of starch digestion in the mouth and stomach and hence nearly the entire weight of carbohydrate digestion is thrown on the pancreas. This was borne out by the fact that 50 gm. of white bread will be easily digested in the mouth and stomach of young people while in the old people only 1% of it will be digested. (30) In further studies made on old people under fasting conditions, it was found that pancreatic amylase is slightly subnormal suggesting that completion of the digestion of carbohydrates is not markedly disturbed in the aged. This is borne out clinically by the fact that old people's diets comprise lots of carbohydrates, yet
the gastro-intestinal symptoms of the aged seldom suggest origin from incomplete carbohydrate digestion. (29) (31).

Further studies were made on the gastric secretion under fasting conditions. These revealed a decrease in acidity in advancing age, as well as low pepsin content. However, it was noted that there was no relationship between the acid and pepsin secretions in fasting gastric juice. It had previously been thought that such a relationship existed. It had also been speculated that decreased acid secretion in old age definitely decreased the activity and secretion of the pancreas. In this series, there were no cases of pancreatic hypofunction in subacidity or anacidity. (31)

Pancreatic secretion of enzymes was also studied by Meier and his co-workers. They found pancreatic amylase to be subnormal as mentioned before but did not feel that the drop was sufficient to indicate any incomplete carbohydrate digestion. Trypsin production, however, was found to drop off after the age of forty years. When stimulated, the pancreatic secretion of trypsin was the same in the old as in the young. Both the proteolytic enzymes, pepsin and trypsin, were
found to be in a concentration of one-fourth of the control group. This would indicate that the old have difficulty in digesting proteins, yet, there is little in the literature to indicate that this condition exists. However, it must be remembered that the diets of the aged are high in carbohydrates and low in proteins because of difficulty in mastication, and this may account for the lack of such symptoms. (31) (29) (40)

The concentration of lipase in pancreatic juice was found to be subject to great variation. The activity of the lipase is but slightly diminished in the aged. It was thought that the diminution of activity was so slight as to not interfere with the hydrolysis of fat in the food. (29) (31)

The liver also undergoes atrophy in old age, yet there does not appear to be any definite impairment of liver function. There are no changes in the secretion of bile in old age. (44) However, there has been described a change in the glucose tolerance curve in senility. In an experiment on fifty-five years of age and with no disease processes detectable,
the fasting blood sugar was normal. Following the ingestion of glucose, it was noticed that the peak of the curve was delayed from one to two hours, and that the duration of the curve was prolonged over two hours. This type of curve suggests a storage defect. This is an important consideration in old age since a storage defect may cause serious difficulty in the presence of infections and other disease. Whether present or not, it may be stated that carbohydrate metabolism as measured by blood sugar curves is definitely impaired in old age. (14)

Appetite is a problem very frequently encountered in caring for the aged and is generally found to be a problem of no small proportion. It has been found that appetite is in some way associated with the tonus of the muscles of mastication and deglutition, and the absence of appetite as well as nausea, is due to atony of these muscles. Such atonic conditions with the accompanying symptoms are common in old people. Carlson states that "a certain sensation complex from the viscera and a normal state of central correlation are a necessary background for appetite as is the memory process of past experiences, (sight, smell,
and taste) with palatable foods. These memories are reinforced by present stimulation of these nerves by food." (8) Diminution of appetite in aged may thus be explained by visual disturbances, and changes in the sense of smell, and in taste buds. The role of the memory process is also definitely important.

The decreased activities of the entire gastrointestinal tract are associated with a decreased metabolism in all tissues in the senile body. The activity of the body cells and the exchange between the blood and the tissues has slackened, and as a result, the metabolism rate in senescence is found to drop. This decrease in cell activity and metabolic exchange between the body fluids and the cell, are greater than the basal metabolism rate of the aged would lead us to believe, because at this time of life, the thyroid function is accelerated.

From histological research carried out on the thyroid glands of fifty-seven aged subjects, it was found that this gland undergoes profound structural modifications. The histological picture of the senile thyroid shows that this organ functions more actively in normal old age than in earlier adult years. There
is found a hyperplasia of the secreting cells, with an increase in the number of secreting granules per cell. This is indicative of an accelerated activity of these elements. There is also a reduction in the number of follicles, and a diminution of colloid present in the follicles which demonstrates a more intense resorption of the same. These conditions correspond to those which have been observed in states of hyperthyroidism and are indicative of hyperfunction. The conclusion reached following these studies are that augmented thyroid secretion is regarded as a phenomena of compensation for the senile decline of metabolism.

"It has been observed how in old age together with evidence of regression (sclerosis and atrophy) certain compensatory phenomena arise: an increase of the elastic stroma of the myocardium tends to compensate for diminished contractile efficiency of the myocardial fiber; the increased peripheral resistance which in later years becomes more and more evident. Likewise we consider the senile hyperfunction of the thyroid as a compensatory phenomena. It affords an additional supply of a notably powerful metabolic stimulant at precisely the time when the activity of the body cells
and the exchange between blood and tissues slackens. While such a hypothesis is difficult of direct proof, it accords with and furnishes a reason for the histological phenomena herein reported."

(15)

Noteworthy are the figures presented by Swinton, who found from a large review of cases of hyperthyroidism, that 5% of all cases of exophthalmic goiter were found in patients sixty years or over. Ten percent of all cases of hyperthyroidism were seen in patients sixty years or over. One third of all cases of adenomatous goiter with secondary hyperthyroidism were found in this advanced age group. (43) These figures perhaps prove nothing. However, when viewed with the histological findings just presented, they would, indicate a correlation between the transformations of the senile thyroid, the frequency of hyperthyroidism in old age, and theory of accelerated thyroid functions in old age.

Research on metabolism rate in senile individuals, has revealed data which at first appears contrary to the histological picture of the thyroid at this time of life. A series of basal metabolism tests were carried out on eight women from seventy-seven to one-
hundred and six years of age and on fourteen men from seventy-four to ninety-two years of age by Matson and Hitchcock. One woman one-hundred and six years old, was found to have a total heat production of 23.81 calories per hour. In calories per hour, per kilogram of body weight, the figure was .749, and in calories per square meter of body surface, the figure was 21.07. The average figures of metabolism tests on six females whose average age was 82.5 years were taken. It was found that their calories per hour per kilogram of body weight was .74 calories. The calories per hour per square meter of body surface was 27.43 calories. The total heat production was 43.65 calories. The average of fourteen men, whose average was 81.6 years, was found to be .82 calories per hour per kilogram of body weight and 30.11 calories per hour per square meter of body surface. It was also found that with neither the men nor the women was there a clear cut indication of any relationship between the degree of senility and the metabolic rate. However, there did seem to be a relationship between the tidal air and senility, the tidal air decreasing as the degree of senility increased. The differences between the sexes
was approximately of the same magnitude as that for adults of less advanced age. On the basis of total calories, the men were 15.4% higher than the women. On the basis of body weight, the difference was 10.8% and on the basis of body surface are 9.8%. (26)

Benedict, who ran a similar series of tests on thirty-six aged women, found that the measurement of heat production on the average is 7% below the Aub and Du Bois prediction standards and 5% below the Dreyer prediction standard, while it was found to be only .2% below the Harris Benedict standard. He believes that the total twenty-hour hours heat production, under basal conditions, of all normal elderly women above sixty-six years of age, whose vigorous physical activities have ceased, is at a constant low level of about 1000 calories. The basic daily energy requirement of every normal woman is placed at 1030 total calories and in old age he believes this basic requirement will be increased or decreased by gross overweight or underweight. In younger ages, the basic daily energy requirements will be increased for the greater energy needs of youth, growth, reproduction and greater physical activity. He concludes that the total metabolism and the
metabolism per unit of surface area of elderly women tend to decrease as age increases but marked over or underweight causes pronounced deviations from the general trend. The heat production per kilogram of weight decreases with increased weights up to 64 kilograms but beyond this weight the metabolism per unit of weight remains at a constant level. Younger women have a higher heat production per unit of weight than do elderly women up to 74 kilograms beyond which it is the same irrespective of age. (2)

Contrary to these findings, if data on rats can be transposed to humans, are the results obtained on aged rats. These figures were taken under conditions supposedly of normal exercise. It was found that the total metabolic rate per twenty-hours in old age is somewhat higher than in middle age. (1) Despite these figures, it would seem that metabolism is definitely decreased in old age.

These changes, anatomical and physiological, found in aged individuals explain to some extent why medical problems in senescence differ from those in maturity. It must be remembered that similar changes are found in every organ and tissue in the body. Only those changes found in the organs and tissue involved in
digestion and metabolism have been described here, and these briefly. There is still much unexplored territory in this field of Geriatrics, and only when a complete understanding of all of these changes is attained, will therapy reach its height of perfection.
Changes during senescence in muscle tone, secretory activity, smell, appetite, hunger, and in metabolism, have been discussed. It will be noted that changes are met in the aged which are sufficiently different from those in maturity to demand special attention to the problem of nutrition of the aged, and such has been the response. The last five, or even ten years has seen a marked increase in the number of articles appearing in the literature dealing with this problem. Considerable has been learned, even more remains unknown, however, certain principles can be laid down and followed with reliance to the benefit of the aged.

The amount of food required as measured in calories per kilogram a day is the greatest in infancy. Here it is almost 100 or more calories. During adolescence it is 35 to 40 calories per day. This however, varies with the amount of work done. Work may bring the calorie requirement up to 60 or 70 per kilogram. At absolute rest, the requirement is 30 calories. (17) In old age the energy requirements are less than those of maturity. This is due to; (1) the basal metabolic rate is remarkably constant between
the ages of twenty to forty. Thereafter, it shows a slow progressive decline. The activity of the tissues even at metabolic rest is slowed down. This is seen in the figures showing the average basal metabolism rate of men between twenty to forty years (37.7) and the rate of men at eighty years (33.57) which show roughly a 10% drop. (2) The muscular work of the aged is less than that of youth and maturity. This latter factor undoubtedly contributes the most to the difference. (16) It has been estimated that the basal requirement of women over sixty-six years of age is 1030 calories. (2) This figure is slightly elevated for men. The following chart taken from Thewlis shows the caloric requirements of both sexes with reference to the amount of activity.
Food Energy—Suggested Daily Allowances

<table>
<thead>
<tr>
<th></th>
<th>60-75 yrs.</th>
<th>Over 75 yrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Active</td>
<td>4150.</td>
<td>3600.</td>
</tr>
<tr>
<td>Moderately Active</td>
<td>2100.</td>
<td>2400.</td>
</tr>
<tr>
<td>Slightly Active</td>
<td>2530.</td>
<td>2160.</td>
</tr>
<tr>
<td>Sedentary</td>
<td>2160.</td>
<td>1920.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>60-75 yrs.</th>
<th>Over 75 yrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WOMEN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Active</td>
<td>2700.</td>
<td>2400.</td>
</tr>
<tr>
<td>Moderately Active</td>
<td>2250.</td>
<td>2000.</td>
</tr>
<tr>
<td>Slightly Active</td>
<td>2170.</td>
<td>1840.</td>
</tr>
<tr>
<td>Sedentary</td>
<td>1890.</td>
<td>1680.</td>
</tr>
</tbody>
</table>

The Care of Aged Thewlis Third edition Mosby 1941

Here it can be seen that the amount of food should be reduced in direct ratio to the activity of the person. Such caloric requirements do not and should not demand a large volume of food since the aged are not capable of handling large quantities without symptoms. For this reason it has been suggested that four or even six small meals a day are to an advantage over the customary three meals a day. (20) (16)

As to the ratio of carbohydrates, proteins and fats in the diet, it should be remembered that in the studies of enzyme secretion in the gastro-intestinal tract, only the proteolytic enzymes were found to be deficient, during old age. Carbohydrates comprise a goodly share of the diet in the aged because of its availability.
and the ease with which such foods can be masticated. A high carbohydrate diet is good in many respects and it is known that a high concentration of glycogen in the liver is a definite protective mechanism. However, if starch is used, it should be thoroughly cooked since starch is digested mostly by pancreatic secretions in the aged and may give rise to symptoms. (7) Fats should be given in sparing amounts, even though enzyme secretion in old age is relatively unchanged, since experience has shown that indigestion often follows a meal containing many fats. Fried and greasy foods seem hard to digest and are often followed by a heavy feeling in the epigastrium. This is most likely due to the inhibitive action fats have on gastric motility.

Concerning the question of proteins in the diet, there is much controversy. Altered physiology of the gastro-intestinal tract in old age would indicate that the protein fraction has of necessity, to be lowered from that found in maturity. Body growth has ceased in the aged and protein is no longer needed for this purpose. This program of low protein intake, especially in the aged, but also in all stages of life, has not only been accepted by the medical profession,
but is a common belief of the lay people. Many disorders have been laid to excessive protein ingestion, and a great proportion of these without scientific basis. In recent years, however, there have been experiments which prove, to the contrary, that high protein is essential to good health. Tuohy states that a higher protein bodily need than is usually considered has been shown necessary by current research on liver function. It has been demonstrated that while carbohydrate diets spare the bodily damaged liver, a protein lack cripples the normal liver. (46) It seems evident that protein is not all immediately utilized unless fixed in living tissue. Arguments have been given substantiating some degree of protein liver storage. Some of the carbohydrates protection afforded comes indirectly through sparing this protein for its more vital purposes. (48) Experimentation on rats subjected to chloroform anesthesia revealed that the damage to hepatic cells after one hour of chloroform anesthesia increased as the lipid concentration in the liver increased. High concentration of glycogen did not seem to protect the liver by itself. Rats which had been placed on high protein diets, however, showed
less liver necrosis. This was especially true of animal proteins. Vegetable proteins were not as efficient. (48) Tuohy believes that a high protein diet is in itself highly protective, especially as to hematopoises and indirectly as to digestion and liver sufficiency, and that protein and Vitamin B are intimately associated in this protective role. His plea is for a freer and broader diet for the aged especially in regard to protein. (46)

Thewlis has set the daily requirement of proteins at .45 gm. per pound of body weight. He believes that the smallest amount of protein upon which the patient can do well is the proper amount. (44) These two contrary views demonstrate, very well, the two sides to the question of protein intake, and only further research will tell which is correct.

It is, however, a well established fact that such conditions as gout and terminal stages of nephritis are contra-indications to a high protein diet. Whether the patient is fed on a high or low protein diet, it should be remembered that the essential amino acids must be included in the proteins prescribed. These amino acids are found in meats, eggs, milk, fish, and
cheese.

Mineral metabolism is likewise an factor in nutrition of the aged. It has been shown defects in this metabolism lowers resistance diseases, especially those of the respiratory t This applies in particular to diets low in calc As seen in all dietary deficiencies in youth an adult life, calcium deficiency plays an important in the osteoporosis and osteomalacia are common examples of this. On the other hand, excessive intake of c is also not advisable. The daily requirement placed at 1.32 gm. daily and iron at 12 to 15 mg. daily. (44) (39)

Carbohydrates, proteins and fats, however, are not used as the factors in determining diets aged individuals. Old people, by necessity, take and need but small portions of food compared to their intake in maturity. Since the volume of food is small, it is important that all the factors vital to good health and well being are included. These factors include calcium, Vitamin A, C, and G. In a study of American and English diets made on histories taken from a cross cut of English and American people it has been determined
that the average diet is most deficient in these factors. Foods capable of supplying these factors are referred to as "protective foods" and include milk, fruit, vegetables, and eggs. So indispensable to human well being are these foods, that diets are now commonly calculated using them as a foundation and rounding out the diet with carbohydrates, proteins, and fats.

Sherman has shown that a diet considered adequate in the sense that it would induce good growth and maintain the adult through a reasonably long life could be improved by enrichment in certain minerals and vitamins. The result has been not only improved growth and a higher level of adult vitality but also an extension of the average length of adult life with a deferred and shortened period of senility. A great deal of evidence has been collected to show that when the protective foods are given an important place in the dietary, the incidence of the so called degenerative diseases is decreased along with the postponement of the signs of actual senility. In his work, Sherman used two groups of rats; one group was fed a diet (Diet A) consisting of dried whole milk, one-sixth, and ground whole wheat, five-sixths, which he considered
unquestionably adequate. To the other group, he fed a diet, (Diet B), with an increase in the proportion of milk from one-sixth to one-third of the solids of the food mixture. This diet, he considers more than adequate. In the group of rats fed on Diet B, he notices a "marked improvement in nutritional well-being and positive health. Death rates are lower, and there are evidences of vitality higher at all ages. In addition to the increase in the average length of life by diminution of early deaths, there is also a well marked increase in the average length of adult-life and the period of the prime of life is extended in even greater ratio than the life cycle itself. It is interesting to note that even those families which had been habituated to the minimum adequate Diet A, thru many generations were still able to respond in the same manner as the families in Diet B." From such research we have come to understand that diets for the old should be more like those for the young in their content of protective foods than had formerly been thought necessary and that a diet richer in minerals and vitamins makes it possible to eat with comfort and a wider range of foods. (41)
Sir Robert McCarrison, established in India, a thoroughly healthy colony of rats. These animals were kept in cages sterilized with creosol solution and regularly exposed to sunlight. The animal room in which the rats were kept was tile and the floors and walls were white-washed. Under these conditions, he kept over 1,000 albino rats. The stock rat was fed a diet similar to that eaten by certain peoples in northern India among whom are some of the finest physical specimens of mankind. The diet consisted of whole wheat flour, unleavened bread lightly smeared with fresh butter, sprouted Bengal gram, fresh raw carrots and cabbage, unboiled whole milk and a small ration of raw meat with bones once a week, and an abundance of water. During two and one-half years, there was no illness among these rats, no deaths from natural causes, and no infant mortality. Autopsys of 1,189 of these rats ranging from infancy to two years, were performed. The only disease discovered was an occasional cyst in the liver from tapeworm larval which it was supposed came from the straw. In the control group of similar number, the same scrupulous cleanliness was maintained. They differed from the others only in that they were
fed a different diet. An effort was made to feed them a diet of the people in India among whom disease was very prevalent and defective stature very common. Of these improperly fed rats, 2,243 were examined at post mortem. The following is a list of the lesions found.

- **Chest**: pneumonia, bronchiactisis, pyothorax, pleurisy, and hemothorax
- **Ear**: otitis media (very common)
- **Nose**: sinusitis
- **Upper Respiratory Passages**: adenoid growths
- **Eye**: corneal ulceration, keratomalacia, parophthalmitis
- **Gastro-intestinal tract**: dilated stomach, gastric ulcer, epithelial new growths of the stomach, gastric carcinoma, duodenitis
- **Genito-urinary tract**: pyonephrosis, hydronephrosis, pyelitis, renal calculus, ureteral calculus, dilated ureters, vesical calculus
- **Skin**: loss of hair, dermatitis, gangrene of feet and tails
- **Blood**: pernicious type of anemia
- **Lymph and other glands**: submaxillary cyst, enlarged and often abscessed inguinal glands, mesenteric and bronchial glands
- **Endocrine system**: lymph adenoid goiter, enlarged adrenal glands, atrophy of thymus
- **Nerves**: polyneuritis
Heart- atrophy, myocarditis, pericarditis, hydropericarditis

Teeth-mal-occlusion and a large percentage of decay. These diseases consist mostly of infections, but degenerative disease is also common. The ill balanced diet fed these rats consisted mostly of cereal grains, vegetable fats with little or no milk, butter or fresh vegetables.

McCarrison's experiment demonstrates the effect of protective foods on health when fed from infancy to adulthood, and although the rats were not allowed to live till senility, it is noteworthy that no evidence of beginning degenerative processes was found in the group. (22)

Langstroth in 1929, made a study of 501 dietary histories of American people. These histories revealed that the non-protective foods formed 88% of the average diet. Bread, butter, meat, potato, and sweet desert formed the greater bulk of this group. These foods are poor in vitamins and contain a high percentage of carbohydrates. The protective foods formed 12% of the diet. Of the 501 diets examined only sixteen showed 30% or more of the protective foods. Milk was nearly always responsible for this.
The percentage incidence of certain degenerative diseases showed an increase as the percentage on non-protective food in the diet decreased. In the group studied, hypertension, myocardial degeneration, arteriosclerosis, arthritis, chronic gastro-intestinal disease, diabetes and unexplained headache appeared more frequently when the previous diet had contained only small amounts of protective foods.

A diet was supplied to 174 patients. All had one disease, ten had more than one. This diet contained 70% protective foods, estimated on the basis of calories.

This diet at times was modified to meet diseased conditions such as ulcer, but the percentage of protective to non-protective foods was maintained as accurately as possible. Other forms of treatment at times supplemented this diet and while they are making the experiment less convincing, they in themselves are known to have only occasional corrective influence on the degenerative disease and cannot be considered as destroying the evidences afforded by the change in diet. The patients remained on the diet from six months to two years.
Breakfast

<table>
<thead>
<tr>
<th>Item</th>
<th>Calories</th>
<th>Protective Foods</th>
<th>Non-Protective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass of orange juice</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two eggs</td>
<td>166</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh fruit</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One glass of milk</td>
<td>160</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Luncheon

<table>
<thead>
<tr>
<th>Item</th>
<th>Calories</th>
<th>Protective Foods</th>
<th>Non-Protective</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-third head of lettuce</td>
<td>16</td>
<td>16</td>
<td>93</td>
</tr>
<tr>
<td>One tablespoon of oil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two fresh vegetables</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One pat of butter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two glasses of milk</td>
<td>332</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh fruit</td>
<td>80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dinner

<table>
<thead>
<tr>
<th>Item</th>
<th>Calories</th>
<th>Protective Foods</th>
<th>Non-Protective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>190</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-third head of lettuce</td>
<td>16</td>
<td>16</td>
<td>93</td>
</tr>
<tr>
<td>One tablespoon of oil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two fresh vegetables</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One pat of butter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One glass of milk</td>
<td>160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh fruit</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
<td>91</td>
</tr>
<tr>
<td>Handful of nuts</td>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTALS</td>
<td>1,450</td>
<td></td>
<td>557</td>
</tr>
</tbody>
</table>

Total Calories 2,147

In the group studied, all patients were placed on the diet presented. There were forty-four cases of chronic circulatory disease, thirty-five with hypertension, four with myocardial degeneration, four with heart pain, and one with intermittent claudication. The following results were seen in the thirty-five cases of hypertension, five showed no change, four
four showed slight improvement, fourteen were much improved and twelve were completely relieved; in the four cases of myocardial degeneration one case showed no change, two were slightly improved, and one was much improved; in the four cases of heart pain, one was much improved and three were completely relieved; and the one case with intermittent claudication showed only slight improvement.

Seventy-five cases of chronic arthritis were present in the group. After living on the protective diet for some time, the following results were noted. Of the sixty-five cases of degenerative arthritis, six cases showed no change, eleven were slightly improved, thirty-one were much improved, and seventeen were completely relieved. There were eight cases of proliferative arthritis. Of these, two showed no changes, three were much improved and three were completely relieved. Both cases of infectious arthritis were much improved. It was noted that while food plays a predominant part in degenerative arthritis, in proliferative arthritis it must be supplemented by long and intensive sun treatment and in infectious arthritis by elimination of foci of infection.
Fifty-five cases of chronic gastro-intestinal disease were studied before and after the diet had been taken. This group contained many types of gastro-intestinal disease, but all patients complained of indigestion. The common symptoms of constipation, lower abdominal pain due to gas, belching, heartburn, epigastric distress or slight pain, and bloating after meals indicated the participation of the entire alimentary tract in this symptom complex. Of these fifty-five cases, five showed no improvement, thirteen showed slight improvement, eighteen were much improved and nineteen were completely relieved.

There were also ten persons with migraine. The corrective diet was prescribed in all and in three cases was supplemented by exercises and in two others by thyroid. Of the ten cases, two showed no change, three showed slight improvement, two were much improved, and three were completely relieved.

Of the one hundred and seventy-four persons given this corrective diet, 73% were much improved or completely relieved. Accompanying changes in body weight, skin, subcutaneous tissues, sclera, visible mucous membrane seemed to indicate a general tissue
change throughout the body.

From these figures, Langstroth concluded that although under ordinary living conditions, deficiency disease is rare, the average American diet is low in vitamins. He finds the American diet high in calories, in carbohydrates, and in its ratio of acid to alkaline ash forming foods, low in vitamins and residue. He has found that there are general tissue changes which often accompany degenerative disease and seems to indicate that some fundamental influence is bringing on a gradual premature deterioration of all body tissues. These changes seem definitely connected with low percentage of protective foods but particularly with large amounts of bread.

The relief afforded by the corrective diet in degenerative disease is partly curative and partly the result of a generalized improvement in the condition of the patient. This latter factor is believed to arise from the reduction of the metabolic load. In the curative sense, relief seems to arise through a partial or complete restoration of injured structures. The degree to which restoration occurs must depend on the amount of injury and on the vitality of the tissues.
readily when an additional 300 mgm. of Vitamin C were added to the diet. The spinal fluid levels were disproportionately low when contrasted with the blood levels and it was found that they rose more steadily. This was believed to be an indication that the central nervous system is a storage place for Vitamin C.

However, no change in behavior was noted to accompany the rise in either the blood or spinal fluid. The conclusion was reached that there is a decreased ability to absorb Vitamin C from the gastro-intestinal tract but that this can be overcome if the concentration in the gastro-intestinal tract is sufficiently raised. (38) Wortis, on the other hand, concluded that absorption probably did not play a part since oral administration increased the ascorbic acid level of the spinal fluid in the aged as in the young. (51) In another series of twenty-five so-called normal aged individuals who received comparitively large doses of Vitamin C, the maximum blood levels did not show any appreciable changes which could be related to the avenue of administration, whether oral or intravenous. (37) It can therefore be
Various means of measuring thiamin in the urine have been devised with better results. In the test of Melnich and Field, only the thiamin is measured. Excretion of less than 70 micrograms of thiamin in adult males or less than 60 micrograms in adult females during a twenty-four hour period in which the subject ingests a diet adequate in thiamin is evidence of a depletion of the body stores of thiamin. In the yeast fermentation test of Schultz, Atkin and Frey, certain substances other than thiamin are included. As a result, their figures are higher and not comparable to those of Melvich and Field. By this method the normal daily excretion for men is considered to be above 400 micrograms and for women 300 micrograms.

Treatment for beriberi and mild cases of hypovitaminosis B is of course the administrative of thiamin. Because of great variation in potency in other preparations, the chemically pure thiamin is the drug of choice. It has been estimated that the requirement is from one to two mgm. daily. This amount is necessary to provide a reasonable margin of
safety. This means about .06 mgm. per 100 calories of the diet. In cases of clear cut deficiency in the adult 10 to 20 mgm. should be taken daily. This dosage is doubled in cases of severe neuritis and cardiac failure. Dosage in mild cases of hypovitaminosis lies sometimes somewhere in between these figures and is governed by the response shown by the patient. (52) Frequently treatment is not given because the patient does not show the variety of symptoms and signs usually demonstrated. Nevertheless inspiring results have been obtained on such cases. Tuohy reports a case of a extreme gastro-intestinal atony who made a remarkable response to parenteral administration of thiamin chloride. (47) Similar effects has been noticed on the heart. (36)

Pellagra, although it has been described as an infectious and a toxic disease, is now generally considered a deficiency disease. Lack of nicotinic acid is responsible for the principle symptoms of pellagra in man. Other members of the B complex may be and undubtedly are often deficient in patients with pellagra. These deficiencies may even contribute
to the symptoms, yet pellagra may be considered primarily a nicotinic acid deficiency disease. In the body, nicotinic acid becomes combined with phosphoric acid to form a co-enzymic and thus becomes a part of one of the essential enzyme systems used ordinarily for transferring oxygen in oxidations concerned with fundamental life processes in the cells.

Pellagra is found over the entire world. In the United States it is a common disease. Although more frequently found in the Southern States, cases are present in considerable numbers all over the United States. It is believed taking into consideration the incompleteness of the reporting of the disease and the sub-clinical stages, that this condition is quite prevalent. When one considers how frequently one or more of the symptoms of this disease is seen every day in persons of poor dietary habits, the prevalence of this deficiency becomes even more apparent.

The typical acute case of pellagra is characterized by a dermatitis, glossitis, stomatitis, diarrhea, and mental symptoms to the point of delirium. In the more mild cases, typical dermatitis, moderate glossitis,
diarrhea, anorexia, indigestion, weakness, nervousness, and mental depression are more frequently seen. Glossitis is one of the first symptoms to appear. The tongue is smooth, red, and sore. In severe cases the papilla atrophy. The dermatitis is the most characteristic symptom but it may not always be present. It occurs over the exposed part of the body with a bilateral symmetry. The skin becomes red and slightly swollen. This may progress to vesicle and bulla formation with cracking. Mental symptoms rarely occur alone, but may be the principle feature of the disease.

Diagnosis of pellagra is made on a dietary history, signs, symptoms, and therapeutic tests. Laboratory findings are not reliable in diagnosis. This can be seen in the results of certain experiments. Chittick and Statz made nicotinic acid determinations in seven patients sixty-five years old or over, in whom there was no physical evidence of nicotinic acid deficiency. The fasting blood levels were found to range from .24 mgm.% to .515mgm.%. Each patient was then given 300 mgm. of nicotinic acid daily for three weeks with no physical evidence occurring, although clinically some of the patients appeared improved. There was no
difference noted in the nicotinic acid levels in various age groups. (12)

The prevention of pellagra in normal individuals can be done by a liberal, well diversified diet. However, this is frequently impossible in senile individuals and the diet must be supplemented. In most cases, this best is done with Brewer's yeast since it supplies other vitamins as well as nicotinic acid. As has been mentioned before, numerous deficiencies may be combined in a case of pellagra and for this reason yeast is recommended. Daily doses of 30 gms. is sufficient for protective purposes. When nicotinic acid is used, 25 to 50 mgm. is sufficient. In mild cases of pellagra, 50 to 200 mgm. of nicotinic acid is desirable, while in severe cases, doses up to 1 gm. may be necessary in the first 24 to 72 hours. As soon as it is possible the patient should be placed on Brewer's yeast. (52)

Closely associated with nicotinic acid deficiencies and frequently seen together with such a deficiency is the deficiency of riboflavin. Riboflavin or Vitamin B₂ forms an oxidation enzyme in the body. Absence or inadequate amounts of riboflavin decreases the
transportation of oxygen in the cells, and this initiates vascularization as a compensatory process. It is interesting to note that apparently many of the physical changes of senescence, have been produced in rats in the course of a few weeks by depriving them of Vitamin B2. Particular effect was noticed on the function of the adrenal cortex. (34)

Symptoms of riboflavin deficiency are inflammation of the lips, fissures at the corners of the mouth, glossitis, dermatitis and vascularizing keratitis. There are also ocular symptoms of photophobia, burning, itching and dimness of vision. With these symptoms, come physical changes, the most common of which is a circumcorneal injection. On these symptoms and signs with the aid of a good dietary history, the diagnosis of riboflavin deficiency can be made. It is difficult to distinguish between a nicotinic acid deficiency and a riboflavin deficiency. Formerly the symptoms of riboflavin deficiency were described as that of pellagra, and even now it is not known that these symptoms may at least in part be due to pantothenic acid (Vitamin B) deficiency. Confirmation of the diagnosis can be
obtained by a therapeutic trial with the pure vitamin. (52)

A deficiency in Vitamin C (ascorbic acid) gives rise to a disease called Scurvy. Frank scurvy is uncommon in adults and during the last years is fast becoming uncommon in children. However, subclinical scurvy or hypovitaminosis C appears to be a fairly common condition. It has been reported that 30 to 40% of people whose diet was considered to be fairly satisfactory were found to have a hypovitaminosis C. This appears to be especially true of aged persons. Bachenon concluded that the delay of saturation of Vitamin C in aged people shows the existence of a hypovitaminosis. He does not venture to state whether the tendency to infections, the delayed healing of fractures in old age, belonging as well to the picture of a hypovitaminosis, are due to the deficiencies of Vitamin C in old age. (4) In tests performed on fifteen patients with senile psychoses, it was found that the Vitamin C levels were low compared to non-senile individuals. These levels were not raised by an ordinary hospital diet containing from 50 to 70 mgm. of C per day. However, the levels came up
It is interesting to note that experiments point to the protective foods as the important elements in increasing inherited vitality.

It was also noted that the relief afforded by the corrective diet disappears with discontinuation of the diet. Having once lost the ability to properly metabolize an excess of non-protective foods, the patient is unable to assume his old eating habits without the return of symptoms. (25)

From this study of the typical American diet, one would judge that mild deficiencies are quite common. To some extent research has substantiated this finding. Especially has this been true in the old age group. Here, finicky appetites, perverted taste, loss of teeth and atrophy of the muscles of deglutition, ignorance and economic status, are big factors in producing such deficiency diseases. Evidence based on official mortality rates which only supply data on cases which demonstrated terminal nutritional failure are shown below. Added to these figures, can be placed numerous deaths unrecognized as nutritional, plus the great number of nutritional deficiencies which do not result in death. Then too, there are believed to be great
numbers of mild subclinical cases of nutritional deficiencies, symptoms from which are not adequate to bring the patient to the physician. (24)

Deaths from Various Causes in U.S. Registration Area 1933-1938

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>1938</th>
<th>1937</th>
<th>1936</th>
<th>1935</th>
<th>1934</th>
<th>1933</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellagra</td>
<td>3,205</td>
<td>3,258</td>
<td>3,740</td>
<td>3,548</td>
<td>3,602</td>
<td>3,955</td>
</tr>
<tr>
<td>Beriberi</td>
<td>42</td>
<td>21</td>
<td>11</td>
<td>7</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Scurvy</td>
<td>30</td>
<td>27</td>
<td>33</td>
<td>30</td>
<td>36</td>
<td>28</td>
</tr>
<tr>
<td>Rickets</td>
<td>244</td>
<td>235</td>
<td>270</td>
<td>261</td>
<td>292</td>
<td>339</td>
</tr>
</tbody>
</table>

Jolliffe et al J.A.M.A. 118-944 March 21, 1942

Absence of vitamin A in the diet results in night blindness, xerosis, xerophthalmia, and a specific dermatosis. These conditions are rarely found especially in adults. An anti-infective function has also been ascribed to Vitamin A as well as an anti-anemic action. Conditions of anemia and lowered resistance to infection are fairly common among old people. Although no accurate method of determining Vitamin A concentration in the body has been devised, it is thought that in senility, where frequently one encounters, lessened appetite and absorption, increased demand for the vitamin, scanty reserve because of previously faulty diets, ignorance, habit,
and poor economical status, a deficiency can be eliminated or substantiated by the response to a diet containing foods rich in Vitamin A. Such foods are cod-liver oil, milk, butter, cheese, egg yolk and green or yellow vegetables. The daily intake for an adult is from 3000 to 4000 international units. This can ordinarily be obtained from the diet. For mild cases of deficiency 20,000 to 40,000 international units are considered ample. In severe cases of deficiency as in night blindness 40,000 to 50,000 units are used marked and rapid improvement.

A deficiency in Vitamin B, (thiamin) results in beriberi. Beriberi is a disease characterized by multiple neuritis, muscular atrophy, cardio-vascular changes, and in many cases, massive edema. This clinical picture is marked by a severe deficiency. A more common picture is that of a mild deficiency or hypovitaminosis which presents a clinical picture with vague neuritic pains, anorexia, digestive disturbances and less severe cardio-vascular manifestations. This condition is said to exist in our southern states but is far more frequently found in the Far East. It occurs in people who fail to ingest
or absorb adequate amounts of the vitamin. Alcoholism, gastro-intestinal disease, diets, ignorance and poverty, are common reasons for this failure. (52) (44)

Diagnosis in the fully developed cases of beriberi is easily made by dietary history and physical examination. However, the diagnosis of a mild Vitamin B deficiency is more difficult. Weakness, fatigue, loss of weight, headache, insomnia, nervousness, loss of appetite, indigestion, gas, constipation, vague neuritic pains, tachycardia, and slight enlargement of the heart are some of many signs found in these mild cases. Laboratory methods of determining thiamin deficiency are yet insufficiently accurate to be of greatest value. It is known that Vitamin B plays an important role in the fundamental processes of oxidation in the body and is active in the oxidation of carbohydrates. When thiamin is deficient, pyruvic acid accumulates in the tissues. This fact has been used in determining thiamin deficiencies. However, various factors vary the amount of pyruvic acid accumulated and until these factors can be controlled, this method of diagnosis remains unsatisfactory.
concluded that Vitamin C can be given orally with no fear of non-absorption. Failure of the blood level to respond immediately is probably due to hypo-vitaminosis existing and the saturation of the tissues. It is believed also that there is a greater utilization of Vitamin C in senility, or else it excreted more rapidly. (12)

The classical picture of scurvy in the adult is that of an afebrile disease marked by lassitude and weakness accompanied by muscle and joint pains. This is followed by petechial hemorrhages in the skin, swelling and bleeding of the gums, tenderness and edema of the legs, and may proceed to large hemorrhage from either the skin or mucous membranes and greater edema. Exactly how these conditions are brought is not known but it is known that Vitamin C is necessary for the maintenance of the normal structure derived from this tissue such as connective tissue, bone, teeth, capillaries etc. Mild cases of deficiency are marked by gingivitis, weakness, malaise, loss of weight, vague pain in the extremities, slight pallor or anemia, and mild changes in temperament.

Diagnosis of scurvy can be made by the signs,
symptoms, and dietary history. This can be substantiated by a number of laboratory tests, and in children and certain cases of adults x-ray findings, are often the only positive basis for diagnosis.

There are three laboratory tests available. One consists of measuring the excretion of Vitamin C in a 24 hour urine specimen. There is a wide range of excretion of Vitamin C found normally, however there is a low level of excretion below which persons on a reasonably normal intake of Vitamin C seldom fall. Most adults on a relatively good diet excrete from 20 to 50 mgm. daily. Excretion of less than 15 mgm. are suggestive of a deficiency. The concentration of ascorbic acid in the blood can also be determined. Serum or plasma are more commonly used. The patient should be in a fasting state when the blood is taken since there is a considerable variation following meals. The normal concentration ranges above 0.7 mgm.\% with 1.2 mgm.\% being about the average. Concentrations from 0.4 to 0.7 mgm.\% are border line and perhaps can be considered as indicative of hypovitaminosis. Concentrations below 0.5 or 0.4 mgm.\% are suggestive of scurvy. Still another laboratory method is the
saturation or load test. Here a large dose of Vitamin C is administered and the effect on the urinary excretion and blood level is noted. In normal subjects the blood concentration rises sharply and much of the dose is excreted in the urine in 24 hours. In deficient subjects the Vitamin C is withdrawn into the tissue almost as rapidly as it appears in the blood. Hence the blood level rises slowly and to a much less extent than in the normal subject. The urine will continue to contain little or no Vitamin C, for the same reason.

Treatment for scurvy or hypovitaminosis C is the administration of Vitamin C. It has been estimated that 50 to 100 mgm. of Vitamin C daily should cover requirements for the adult. This means from .8 to 1.6 mgm. per kilogram of body weight. For the aged, the diet should contain 100 mgm. This amount of Vitamin C can be obtained in 200 cc. of orange juice of good quality. For cases of hypo-vitaminosis C and very mild cases of scurvy, an additional 100 mgm. of Vitamin C should be given. This can be included in a diet. However, if the patient is unable to take the diet or will not take the diet, it can be given in pure form by
mouth, or intramuscularly, or intravenously. In severe cases of scurvy such measures are most likely to be necessary. (52)

In all probability, elderly people are not deficient in Vitamin D. It is believed that they obtain sufficient amounts from sunshine. This may not be true during the short cloudy days of winter.

The vitamin deficiency relatively common to senile individuals has been discussed. It is still debatable if the aged require more vitamins than the mature. It has, however, been fairly well established that the aged often carry vitamin levels. When one considers the finicky eating habits, the inability of many to masticate anything but soft foods, and the economic status of many old people, this can be easily appreciated, and when ever these factors are found present in any case, vitamin deficiency should be proven absent before discarded as a possibility.
CONCLUSION

The nutritional requirements of an individual change with every stage of life. This is true of the change from maturity to senility. A basis for this is seen in the anatomical and physiological changes that occur in the gastro-intestinal tract as seen in studies of the same in senile individuals. Additional factors are mental changes, fixed habits, economic status, and possibly greater requirements of certain foods. It is believed that considerable can be accomplished in prolonging the age of senile individuals as well as making these years more comfortable by furnishing them with correct diets. It must be realized that in order to obtain the maximum benefit from correct nutrition that such a program must be started in infancy and continued throughout life. At present this would be an impossibility. However, through education such a goal may be reached in some future time. That some control of the degenerative disease which are fast becoming the common cause of death, can be maintained by adequate diet has been demonstrated in several experiments. It is possible that in the future when the many unanswered problems in nutrition are solved, even more control of these diseases can be gained. It is not proposed that the answer to Geriatrics
lies in nutrition alone. Geriatrics is a problem of many of the branches of medicine as well as a philosophical and economical problem, yet is believed that the greatest possibilities lie in nutrition.
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