Can the recorded knowledge of this disease aid in the solution of our modern disease problems?

Have We Forgotten the Lesson of *Scurvy?*

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From the 14th to the 19th century, scurvy took the lives of millions annually in Europe and Asia. From 1600 to 1800, it is estimated that fully a million English sailors succumbed to this disease. In the early history of these pandemics the designations "Plague" and "Black Death" were used, but from a study of the characteristic symptoms: multiple hemorrhages under the skin (red, purple and black spots and hematoma) and from all mucous membranes — gastrointestinal, pulmonary and genito-urinary; and intramuscular and subperitoneal as well as subperiosteal effusions and cartilaginous disintegration in general, it may be assumed that these designations, for lack of better terminology, may be used interchangeably. At any rate there have been no pestilences of this nature since Lind, a Scottish surgeon, found the cause and cure of this disease over 200 years ago.

James Lind, a medical officer of the British navy, made this epochal discovery in 1747, aboard H.M.S. Salisbury at sea, when he made trial of a half dozen or more popularly recommended treatments, which he reported as follows: *"I took 12 patients in scurvy on board the Salisbury. They lay together in one place in the fore hold and had one common diet-water-gruel sweetened with sugar in the morning; fresh mutton broth often-times for dinner, and for supper barley and raisins, rice and currents, sago and wine, or the like. Two of these were ordered each a quart of cider per day. Two others took 25 gutts [drops] of elixir vitriol three times daily on an empty stomach. Two others took 2 spoonfuls of vinegar thrice daily on an empty stomach. Two of the worst patients were put on a course of sea water, of which they drank one half pint daily. Two others had each two oranges and one lemon given them every day; these they eat with greediness, at different times, on an empty stomach. They continued but six days under this course, having consumed the quantity that could be spared. The two remaining patients took the bigness of a nutmeg thrice daily and of an electuary recommended by a hospital surgeon, made of garlic, mustard seed, horse radish, balsom of Peru and gum myrrh . . .The consequence was that most sudden and visible good effects were perceived from the use of the oranges and lemons, one of those who had taken them being at the end of six days fit for duty . . . The other was the best recovered of any in his condition, and being now deemed pretty well was appointed nurse to the rest of the sick." (31)*

Dr. Lind, like many other researchers, did not live to see his discovery given general acceptance. He died in 1794, and in the following year, the British Admiralty

made provision for a daily ration of lime or lemon juice to be given all sailors in the navy, and in consequence, even to this day, the sailors of the British navy are dubbed "limies." During the time between this discovery and its practical application (44 years), nearly 200,000 British sailors died needlessly of scurvy.

The postmortem findings of Lind and his contemporaries are most revealing. Lind reports that he found the muscles of scurvy victims so lax and tender that they readily fell apart, the intestinal musculature the same, and he comments: *"Why the scurvy should so frequently and in so singular manner affect the cartilage of the ribs, so as sometimes to separate them altogether from their connection to the breast bone . . . I own I am at a loss to account for."* (18) He also reported a number of scurvy cases in which old fracture calluses and old scar tissue was broken down. He cites Martini (1609) as stating that *"scurvy is nearly allied to the Plague, as it occasions carbuncles, buboes and cancer."* Willis, the great English anatomist, relates in his *Tractus de Scorbuto*, *"A crackling of the bones upon moving the joints, even upon turning in bed, by rubbing of the vertebra upon each other . . . like to the rough handling of a skeleton."* Poupart, the great French surgeon, in reporting his findings in Paris scurvy victims, states: *"In some, when moved we heard a small grating of the bones. Upon opening their cadavers the epiphyses were found entirely separated from the bones, which by rubbing against each other had occasioned this noise. In some we heard during life a small low noise when they breathed. In these [postmortem] the cartilages of the sternum were found separated from the bony part of the ribs . . . The ligaments of the joints were found corroded and loose ... All the young persons under 18 had in some degree their epiphyses separated from the body of the bones."* (32)

After the discovery and isolation of vitamin C in 1928, and the establishment of its causal relationship to scurvy, the declining incidence of this disease has led to complacency, scurvy being thought of as a well-nigh extinct disease. This has resulted in failure to recognize and treat subclinical forms of this disease and its complicating relationship to many other diseases.

SUBCLINICAL SCURVY IN OBSTETRICS

In 1948, a paper of mine, *"The Striae of Pregnancy: A New Etiological Concept,"* (1) we reported clinical and laboratory findings in support of the thesis that these disfiguring subdermal lesions, which for centuries were regarded as a natural sequence of pregnancy, are the result of increased fragility of the involved abdominal connective tissue, secondary to deficiency of vitamin C. We quote from the summary as follows: *"The literature relative to the striae of pregnancy is reviewed, and Crede's classical treatise is cited as most complete. All authors seem to agree that the striae are produced by rapid and extensive stretching of the skin and underlying connective tissues in the presence of decreased elasticity of the same. None, however, has elicited the specific factor causing this lack of elasticity."* Based on the recently established knowledge that deficiency of vitamin C is conducive to decrease in tensile strength of tissues generally (2, 3), the hypothesis that C-hypovitaminosis is the culpable etiological factor in striae gravidarum is advanced. It is intimated that other obstetrical complications

involving the tensile strength and elasticity of tissue, including cervical and perineal laceration, abdominal hernia, rupture of the uterus and hemorrhage (pre- and postpartum) may also be similarly related.

Clinical data regarding the correlation in the incidence of the striae and the plasma ascorbic acid level in a series of 26 gravid women are presented. In general it was found that the degree of striation was inversely proportionate to the ascorbic acid level. Although the majority of the subjects were multiparous, 50 per cent of the series were found to be free from striation. Ninety years ago, according to Crede, only 10 per cent of gravid women were exempt from striae. We attribute this marked reduction in incidence to the increased consumption of citrus and other fruits of high vitamin C content within the last century.

SUBCLINICAL SCURVY AND THE RHEUMATIC DISEASES

Lind cites Sennerti (1624), who, writing on scurvy, states: *"In some, though more rarely on each motion of their joints, a noise was heard as from broken bones or like the crackling of nuts [crepitus]."* This is suggestive of our modern arthritic lesions. Engaleno, also cited by Lind, states that *"gout is known to proceed from scurvy, by not being fixed but shifting from one joint to another and its being quickly cured by antiscorbutics."* (18) Harvy, also cited by Lind, divides scurvy into three kinds — mouth scurvy, leg scurvy and joint scurvy.

If such articular lesions were found in times past in frank scurvy cases, it is only logical to conclude that similar lesions of lesser degree, such as we now find in chronic rheumatic disease, may be etiologically related to deficiency of vitamin C. Our modern knowledge of this vitamin may thus provide the linkage between scurvy and these diseases. James Rinehart and Stacy Mettier (4) were the first modern writers to correlate deficiency of vitamin C with rheumatic disease. In animal experiments, they found that prolonged deficiency of this vitamin in the diet produced functional impairment and anatomic changes in the joints. Throughout this research the concurrence of infection, superimposed on vitamin C deficiency, is stressed as being jointly involved in rheumatic etiology. The writer of this thesis adopts a modification of this concept in regarding both the infections and the arthritic phenomena as the sequelae of vitamin C deficiency.

Recently the author of this thesis has made therapeutic trial of massive doses of vitamin C (1 to 10 grams daily), intravenously and orally, in a number of cases of rheumatic fever. The patients made rapid and complete recovery in 3 to 4 weeks without cardiac complications. Similarly favorable results have been obtained in incipient arthritis. We therefore believe that the rheumatic diseases should no longer be regarded as of unknown etiology.

SUBCLINICAL SCURVY AND INTERVERTEBRAL DISC LESIONS

Our knowledge of the pathology of the intervertebral discs has been developed mostly within the last three decades. It is more than likely that lesions of these structures were equally if not more prevalent in earlier times, but were not generally recognized until x-ray technique became a major factor in physical

examination.

The possibility of preconditioning factors, in the form of degenerative changes, has been intimated by most writers, but the exact nature or cause of such changes has not been established. According to Beedle (5), *"It is submitted as the most probable theory that certain faults in the texture of the cartilage matrix occur . . . and give rise to the rupture of the cartilage by minute traumatic influences that would have no effect on normal tissue."* As degenerative changes advance in the disc structure the elasticity of the same lessens, and this loss of function is sometimes hastened by deposition of calcium, and the efficiency of the confining fibro-elastic network is lost. When the stage of rupture and herniation is reached, the resultant lacerations are often accompanied by extensive hemorrhages, which further complicate the picture. That these lesions are not due to senile degenerative changes is shown by the age incidence, beginning in the second decade, it reaches its peak in the fourth, after which it gradually declines. Key (6) has reported intervertebral disc lesions in young children and adolescents.

From a carefully correlated study of the nutritional background of subjects of these lesions, and from the records of analogous postmortem findings regarding the condition of cartilaginous structures in scurvy, as cited by Lind in his treatise on this subject (1753), we are convinced that deficiency of vitamin C plays an important role in the *etiology* of these lesions, as well as in those of the semilunar cartilages of the knees, the sacroiliac synchondroses, etc. It seems obvious therefore that therapeutic use of the vitamin should be made as part of the non-surgical care of all such cases. It is conceivable that such means might result in fixation of a slipping disc or cartilage and prevent rupture or herniation of same. "A stitch in time saves nine."

SUBCLINICAL SCURVY AND PNEUMONIA

In 1936, Gander and Niederberger (7) found that vitamin C favorably influenced the course of pneumonia. When the vitamin C status was brought up to normal saturation level early in the disease the temperature dropped abruptly to normal and the pain subsided. The pulse remained of good tone, and remarkable general improvement was made. In the same year, Hochwald (8) independently reported similar results, his findings indicating that massive doses of vitamin C 500 mg. every 90 minutes, until the temperature drops to normal, exerted a curative effect in croupous pneumonia as shown in lessened prostration and dyspnea, earlier return to normal temperature and to normal white blood cell picture. More recently, the author of this treatise had occasion to treat a case of bilateral pneumonia in a middle-aged man. The temperature was 104 and both lungs were almost filled with exudate. Treatment was begun with 1000 mg. vitamin C intravenously, followed by 500 mg. orally with a half glass of orange juice every hour. On second call, 7 hours later, the intravenous injection was repeated. At that time the temperature was nearly normal. This same treatment was continued for three days, by which time the pulmonary exudate had practically cleared. On the fourth day, the patient felt so well that he voluntarily resumed work with no adverse effects. In 1944, Slotkin and Fletcher (9) reported on the prophylactic and therapeutic value of vitamin C in postoperative pneumonia. They summarized their findings as

follows: *"Pulmonary complications in old debilitated patients requiring prostatic surgery is a common cause of death. The pulmonary lesions most noticed were bronchopneumonia, lung abscess and purulent bronchitis. Most of these cases are 'wet chest" due to capillary secretions. Vitamin C, which increases the tonicity of these capillaries, has greatly alleviated this condition and promptly restored normal pulmonary function."* Slotkin (10) further reports that since publication of his paper on this subject *"vitamin C has been used routinely by the general surgeons in the Millard-Fillmore Hospital, Buffalo, as a prophylactic against pneumonia, with complete disappearance of this complication."* Terminal pneumonia is often the cause of death in frank scurvy, and the "rusty-brown" sputum of pneumonia may owe its origin to the hemorrhagic status of subclinical scurvy.

SUBCLINICAL SCURVY AND TUBERCULOSIS

Tuberculosis has long been clinically related to scurvy and vitamin C deficiency, and has been favorably influenced by concurrent vitamin C therapy. Richard Morton, one of the earliest writers on this disease, says in his famous *Phthisiologia* (1689): *"Scurvy is wont to occasion a consumption of the lungs."* Harris (11) finds that the excretion of vitamin C is decreased in tuberculosis, that this deficiency reduces the resistance of guinea pigs in tuberculosis, and that similar effects have been observed in man. Bauer and Vorwerk (12) report vitamin C deficiencies of from 1 to 4 grams in tuberculosis cases. They state that there seems to be certain parallelism between the activity of tuberculosis and the extent of vitamin C deficiency. McConkey (13) reports that of 437 pulmonary cases admitted to a New York State Hospital for Tuberculosis in 1926 and 1927, 47 developed intestinal tuberculosis; whereas, of 399 admitted in 1928 and 1929, who received a prophylactic treatment consisting of 3 oz. of citrus or tomato juice and 3 oz. of cod liver oil with each meal, only 3 developed intestinal tuberculosis. Furthermore, of 913 other patients admitted during 1930 to 1938, who received the same prophylactic treatment, only 9 developed intestinal tuberculosis. Borsalino (14) reports a study of 140 tuberculous patients, in which administration of vitamin C rapidly increased capillary resistance and stopped hemotysis, which reappeared when the treatment was discontinued. Moore et al., (15) in a recent survey of nutrition among the northern Manitoba Indians, report a very high mortality rate from tuberculosis and pneumonia (761 and 383 respectively, per 100,000). In the tribes covered by their study, the death rate for tuberculosis in 1942 was 1400 per 100,000. The figures for the white population of Manitoba at that time was 27 per 100,000. The daily per capita food intake they found most deficient in vitamin C less than 1/71 of the recommended allowance. In conclusion they say: *"It is not unlikely that the Indian's great susceptibility to many diseases, paramount amongst which is tuberculosis may be attributable to their high degree of malnutrition."*

SUBCLINICAL SCURVY AND CORONARY THROMBOSIS

Coronary Thrombosis first made its appearance in our vital statistics about fifty-years ago, since which time its incidence has been steadily increasing until now it heads our mortality list in the vascular disease group, and tops our mortality figures generally. The major clinical feature of this disease is the development of a thrombus on the

intima of the coronary artery at a point of threatened breach, and gradually building up until in the course of weeks, months or years it occludes the lumen of the artery. As this state approaches the patient suffers heart pains and shortness of breath, and in many cases it culminates in a fatal seizure.

Paterson (16), of the Ottawa Civic Hospital, in a series of autopsies on coronary cases, frequently found a capillary hemorrhage at the site of the thrombosis, which he regarded as an etiological prelude resulting from deficiency of vitamin C. In support of this conclusion, he found that 81 per cent of his coronary cases had a subnormal level of vitamin C, compared to 55 per cent in a corresponding group of general public ward cases. Accordingly, he suggested that coronary patients be assured of an adequate intake of this vitamin. *Willis (17) has shown that scurvy (or extreme deficiency of vitamin C) in guinea pigs is prone to cause thrombotic lesions identical with those of the human disease.*

SUBCLINICAL SCURVY AND CANCER

As long ago as 1609, Martini (cited by Lind) stated that scurvy is nearly allied to the plague, as it occasions carbuncles, buboes and cancer. In an effort to clarify this relationship we published two papers (18) in which we advanced the hypothesis that deficiency of vitamin C, by bringing about disintegration of epithelial and connective tissue relationships, owing to liquefaction (19) of the intercellular cement substance (collagen) and disintegration of the connective tissue of the basement membrane, results in breakdown of orderly cellular arrangement, thus acting as a prelude to cancer. Pirani and Catchpole (20) found that glycoprotein (collagen) thus liberated finds its way into the blood stream, resulting in an increased serum level. Wollbach (21) found that administration of vitamin C in scurvy rapidly restores the normal consistency of collagen. Simkin et al (22) report an increase of serum glycoprotein (collagen) in cancer. Studies by Wingler (1953), Greenspan (1954), Locky et al. (1956), and Lansing (1957) have confirmed this finding. A correlation of these findings gives support to our hypothesis. As further evidence, a diagnostic test for cancer has been developed in Germany (the Whitting reaction) based on the blood-protein picture (23).

Schneider (24) cites Eickhorn as finding a pronounced deficiency of vitamin C in cancer cases, averaging 4,550 mg. by the saturation method, while his non-cancerous controls averaged only 1,350 mg. Bodansky et al. (25) studied the vitamin C level of blood plasma and white blood cells in cancer cases compared to non-cancerous cases. They found the levels in the former to be significantly lower. Russell et al. (26) report that recurrent periods of scurvy, interspersed with periods of lettuce supplementation to prevent death, resulted in a significant shortening in the time of appearance of induced cancer in guinea pigs.

In accordance with these observations, may it not be maintained that the degree of malignancy in cancer is inversely proportionate to the degree of connective tissue resistance, which in turn is dependent upon the adequacy of the vitamin C status? Scirrhous cancer of the breast is slow to metastasize and may remain inactive for many years; whereas the medullary (soft) cancer of the breast is extremely invasive. In the former, there is predominant connective tissue stroma

which cohesively binds the cells effectively, thus curbing metastasis; while in the latter the structure is mainly cellular and almost completely lacking in connective tissue binder, thus favoring metastasis. This variation in invasiveness is usually attributed to some intrinsic property of the cancer cells; but our hypothesis relates it to the acquired connective tissue resistance of the host. In other words, cancer is a disease that we unwittingly cultivate or contract by perverse habits of life. The wise man (Solomon) has said "The curse causeless shall not come" (Proverbs 26.2). Ravdin, I. S. (27) has said: *"While surgery and radiology are helpful, they do not attack the underlying biological defects . . . Some time, some place, the existing jigsaw puzzle will be properly put together, and we shall wonder why the correct answer evaded us for so long a time."*

The implications from these observations strongly suggest that our major effort should be directed toward prevention of the cause of the cellular disarrangement – Collagenous breakdown of epithelial and subepithelial connective tissues – as manifested in open sores or fissures that fail to heal readily, and unusual or easily-produced hemorrhage. Such lesions may be early warning signs of future cancer. They likewise are early signs of scurvy. Advance indications of such conditions may be noted in female subjects who bruise easily, as shown by unaccountable "black and blue" spots. We have found that fully 90 per cent of our adult female population are so afflicted, and by chemical test are found to be deficient in vitamin C.

Our observations in this respect have led us to the conclusion that the major cause of vitamin C deficiency in our modern civilization may be the well-nigh universal tobacco addiction. The smoking habit not only militates against normal nutritional practice, but *actually neutralizes or destroys to a great extent what little vitamin C is taken in food.* We have found by clinical and laboratory means, in checking the vitamin C requirements of subjects while smoking and not smoking, that *the smoking of one cigarette, as ordinarily inhaled, tends to neutralize in the body about 25 mg. of the vitamin, or that contained in an ordinary orange (28).* This reciprocal effect is due, we think, to the chemical action of ascorbic acid as an oxidizing or reducing agent. Our findings in this respect have been confirmed by independent research in U.S.A. (29) and in Europe. On the basis of our hypothesis these findings would help to explain the phenomenal increase in lung cancer and the current upsurge in the incidence of leukemia in newborn infants and young children, which we have dealt with in a recent treatise (30).

In further support of this new concept of etiology we cite Dr. Felix Pincus, Germany, on the subject of "Acute Lymphatic Leukemia" in *Nothnagel's Encyclopedia of Practical Medicine,* American Edition, W. B. Saunders & Co., Philadelphia, 1905, sub-section "Acute Lymphatic Leukemia," pages 552-574, as follows: *"The most striking clinical symptoms of this disease are the hemorrhages and their sequelae. We refer especially to hemorrhages into the skin, the invisible mucous membranes and the posterior eye ground; and further the hemorrhages in the interior of the body-those that are recognizable during life by their clinical results, as of the intestine, the bladder, the brain, and the labyrinth of the ear. Sometimes large and deep necroses of*

the skin arise, which spread rapidly and show not the least tendency to heal. The teeth sit loosely imbedded in the spongy remains of the mucous membrane. Every touch produces hemorrhage, making a condition completely identical with that of scurvy. Especially interesting in this regard is the case of acute leukemia in a 17-year-old girl who never, or at most rarely, ate fresh vegetables, a deficiency always named among the primary causes of scurvy."

This close linkage with scurvy seems to have been completely overlooked by modern writers on leukemia, the major stress being given to genetic changes in chromosomes, irrespective of possible adverse maternal contributory factors. Ingalls (1956) has this to say: *"Congenital defects are not all determined at the moment of conception; many are acquired during the ensuing fetal development. The latter are usually fetal manifestations of critical stress on the mother during pregnancy. Just as the genetically determined defects have been studied in the fruit fly by breeding experiments, so the acquired defects have been studied in the gravid mouse by the use of hypoxia (lack of oxygen) as a standard stress applied to the mother. A large class of congenital defects is therefore preventable."*

This new theory of the relationship of vitamin C deficiency in carcinogenesis suggests the possibility that all physical and chemical carcinogens may act indirectly by bringing about or exaggerating a latent deficiency of this vitamin. A comparable situation has prevailed regarding alcohol. For many years, it was thought that alcohol was the specific cause of peripheral neuritis in the alcoholic subject, but it is *now known that deficiency of vitamin B_1 is the cause,* the alcohol only increasing the requirement of the vitamin.

CONCLUSIONS

In conclusion, it would seem that an optimal body level of vitamin C offers the best natural means of assuring healthy connective tissue and building natural resistance against any and all the diseases referred to in this treatise.

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