

THE RELATION OF MUSCULAR ACTIVITY TO CARCINOMA¹

A PRELIMINARY REPORT

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Carcinoma in men, especially retired farmers, has been frequently seen by us in the past few years. These patients, men with large, well developed bodies of the "frontiersman" type, usually gave a history of having retired from the farm in good health, a few years previously, to enjoy a well deserved rest. On the other hand we have often talked with farmers, who for one reason or another still shouldered the responsibilities of the farm, who were well and working hard though sixty, seventy, or even eighty years of age. This observation brought us to consider muscular activity in relation to carcinoma.

There have been no deaths from carcinoma among the Turn Teachers (1) in the past thirty years. Thirty deaths from all causes occurred in this period, and we should expect at least three deaths from carcinoma. The Turn Teachers are of necessity active in a muscular sense. While the list is not large, the exception to the rule is interesting.

We have repeatedly noted that patients, clinically diagnosed as precancerous, improved in a most satisfactory manner on a prescription for increased daily exercise, as rope skipping for women, golf and brisk daily walks for men.

Muscular activity stimulates metabolism and retards the approach of senescence and decay. The tuberculosis problem has been greatly simplified by the recognition of the value of rest, sunshine, wholesome food and fresh air. We believe that the

¹ Read before the Hennepin County Medical Society March 6, 1922.

carcinoma problem may also be simplified by the recognition of the value of muscular activity in those periods of life most affected by carcinoma, those periods of life when we are prone to "let down" and check our pace. If muscular activity has an intimate relationship to carcinoma, the value of it will be most apparent in prophylaxis, the field which to date promises the most in the attack on this malady.

In a perusal of the literature we are unable to find any direct reference to the relation of muscular activity to carcinoma.² Hoffman (2) shows that carcinoma is world wide, is a disease of maturity, affecting both sexes and seriously affecting all civilized nations and races. Observations are quoted and statistics are presented showing that carcinoma is more frequent among the unoccupied, among people of independent means, among the leisured and professional classes, among the overnourished, well housed, well fed, and among those who live in the warmer climates. Carcinoma is less frequent among the people who are actively engaged in a gainful occupation, among the hard working classes, among those who live in large industrial centers, among peoples predominately poor and of necessity frugal, living on an alimentation just sufficient for their actual needs, and among those who live in the colder climates where the struggle for existence is more difficult. Reading between the lines one common factor is noted, that of the varying degree of muscular activity. The vast majority of people follow the line of least resistance and those of independent means, the leisured and professional classes, and those who live in the tropics are not compelled to do manual labor as a means of gaining a living and hence are less liable to be active in a muscular sense. Attention must be called to Dublin's (3) conclusion with reference to the experience of the Metropolitan Life Insurance Company for 1914, 1915, 1916, that "the cancer

² It is interesting to us to find that in another part of the world similar ideas have been advanced almost simultaneously. Cherry, of Melbourne, on March 1, 1922, read a paper on A Theory of Cancer (published in Med. Jour. of Australia, April 22, abstracted in J. A. M. A., 1922, lxxix, 245) in which he attributes the recent increase of cancer to deficient muscular activity, overnutrition, and lessened skin activity, as a result of modern living conditions of civilized peoples.

mortality rate at ages where the cancer rate is significant, decreases as we go up the economic scale." To reconcile the statistics presented by Hoffman with those of Dublin one must admit that other factors than the economic status are present.

Ewing (4) states that "statistics show that sanitary measures which control infectious diseases exercise no such power over carcinoma, which is somewhat conspicuous by a relative failure to attack the poor, the overworked, the underfed, the savage, but chooses a notable proportion of its victims among the well-to-do, the well nourished, the well protected against infectious diseases, and the indolent."

Ewing has noted also that carcinoma seems to be as widespread as are animal species. The mortality from malignant tumors among pet dogs is reported to be surprisingly high. Forms of carcinoma in horses, cattle, and swine are relatively common, carcinoma of nearly every organ of fowls has been reported, mice and rats are subject to carcinoma and made use of extensively in the laboratory. It is very interesting to note that he too calls attention to the rather sharp fall in carcinoma incidence when one takes up the consideration of carcinoma in wild animals. In this respect one must also consider that wild animals have not been subjected to uniform close study, autopsies have been less frequent, and violent deaths have been more common than among the domesticated animals. McCoy (5) reports autopsy findings of 100,000 rats (95 per cent of which were *Mus norvegicus*) caught during the San Francisco rat campaign about fifteen years ago. Of these rats 103 were found to have tumors, of which 10 proved to be carcinoma. Thus he found that about one rat for every thousand had a new growth, and only 1 in 10,000 had a carcinoma, the remainder being benign tumors or sarcomata. In addition to the factors incident to the study of carcinoma among wild animals, the necessary muscular activity of the animal in its natural wild state may have a bearing on the relative infrequency of reported carcinoma.

Carcinoma has been observed under certain conditions among artificially bred fish (6). It has been clearly shown that fish kept under artificial conditions are more susceptible to the

development of carcinoma than are those living under natural conditions. We believe that the enforced inactivity of the fish in ponds and hatcheries is a potent factor in the development of carcinoma. The dietary factor must also be considered.

The present day labor saving machinery, convenient means of transportation, and ultra-conveniences of modern life all tend to make us less active physically, and it appears to us that the increasing curve of carcinoma closely approximates the inauguration of the Age of Machinery.

The recent researches into the finer biochemical changes attending the metabolism of carcinomatous patients point to the development of carcinoma as an individual biological reaction to chronic irritation, governed possibly by the previous state of metabolism. It would seem that we must look to the biochemist for information as to the exact cause of the reversion of the adult cell to fetal characteristics. The researches of Freund and Kaminer (7), Rosenthal (8), Neuberg (9), Koritschoner and Morgenstern (10), and others are very interesting in this connection.

This opportunity is taken for the presentation of a working hypothesis: That human carcinoma may be the reaction to and the result of chronic irritation of adult epithelial tissues bathed in body fluids altered by certain metabolic products as a result of deficient muscular activity.

In advancing the above hypothesis constructive and destructive criticism is invited, as by intensive cooperative effort sufficient data pro and con will be obtained definitely to prove or disprove our contention.

An investigation in an experimental way of some of the phases of muscular activity and its relation to carcinoma is being conducted which will be reported in the near future. We refer especially to the investigation of the effect of muscular activity on experimental carcinoma in mice. We are also preparing to ascertain the effect on human carcinoma of horse serum obtained after graduated amounts of muscular activity.

In an effort at this time to gain some concrete evidence bearing on the subject, a study of carcinoma in Minnesota for the past

three years was undertaken. Access to original certificates of death was obtained through the courtesy of the Bureau of Vital Statistics, Minnesota State Board of Health, there being no compilations available. Among 86,838 records examined 6,351 deaths were ascribed to malignant disease for the years 1918, 1919, and 1920. Sarcoma was named as cause of death in 452 records. There were 3135 deaths from carcinoma among males, and these were used as the basis for the present study. Carcinoma among females was not studied at this time because of the difficulty in estimating the amount of muscular activity relative to occupations of this sex. The deaths were tabulated according to occupation and the occupations divided by us into six groups according to our idea of the muscular activity necessary to that occupation. It is to be regretted that no scientific criterion was available for this classification. Some method as suggested by Waller and DeDecker (11) might be applicable if standardized by sufficient usage. We have tried to use our best judgment in each case. A special report was obtained from the Bureau of Census on the number of persons engaged in each occupation based on the Census of 1920. The deaths in each group for three years were totalled, averaged, the number of persons engaged calculated and the death rate computed on the basis of 100,000 persons engaged to bring each group to a common ground for comparison. The death rates are in a measure not absolutely reliable because of the short period of time under consideration and the present day laxness of the average undertaker in completely filling out certificates of death. We grouped the occupations as follows: Group 1. Occupations involving great muscular activity. In this group are included stonecutters, blacksmiths, boilermakers, moulders and the like. Group 2. Occupations involving moderate amounts of muscular activity, as carpenters, cabinet makers, common laborers, masons, plumbers, and the like. Group 3. Includes occupations involving medium amounts of muscular activity as foremen, millers, brewers, agents, printers, etc. Group 4. Occupations involving small amounts of muscular activity, as the professions, office workers, and the like. Group 5. The farmers, because of the

seasonal character of their work in Minnesota, were classed alone. Group 6. This group includes those not actively engaged in any gainful occupation, students, idiots, epileptics, inmates of insane hospitals, and those who have retired from gainful occupations.

Hoffman (12) reports the following statistics:

Death rate per 100,000 males, England-Wales, thirty-five years of age and over

	1890-1892	1900-1902
All males.....	165.5	210.3
Occupied.....	146.0	180.0
Not occupied.....	359.0	503.8

The differences in mortality are very striking and we believe they may be explained on the basis of muscular activity.

In Minnesota for the years 1918, 1919, 1920 we have found the death rate per 100,000 males as follows:

1. Those 21 years of age and over:
 - a. Active (groups 1, 2, 3, 4, 5)..... 103.5
 - b. Inactive (group 6)..... 510.0
2. Those 45 years of age and over:
 - a. Active (groups 1, 2, 3, 4, 5)..... 285.8
 - b. Inactive (group 6)..... 681.0

The figures for Minnesota are seen to parallel roughly those for England and Wales (see chart 1).

In a consideration of the age class 21 years of age and over we have found the death rate from carcinoma lowest in group 1 (in which the necessary muscular activity is greatest) and highest in group 6 (in which the necessary muscular activity is least). There is a stairstep gradation between the extremes. The ratios between the death rates in the various groups may be thus expressed: I:II:III:IV:V:VI: 1::1:1.7: 2.1:2.3:3.6: 11.8 (see chart 2, table 1).

To ascertain the ratios in the various age classes we have subdivided the active groups:

A. Those twenty-one to forty-four years of age. In this age class the ratios may be expressed thus: I:II:III:IV:V::1:1.4: 1.5:2.2:2.0 (see table 2, chart 3).

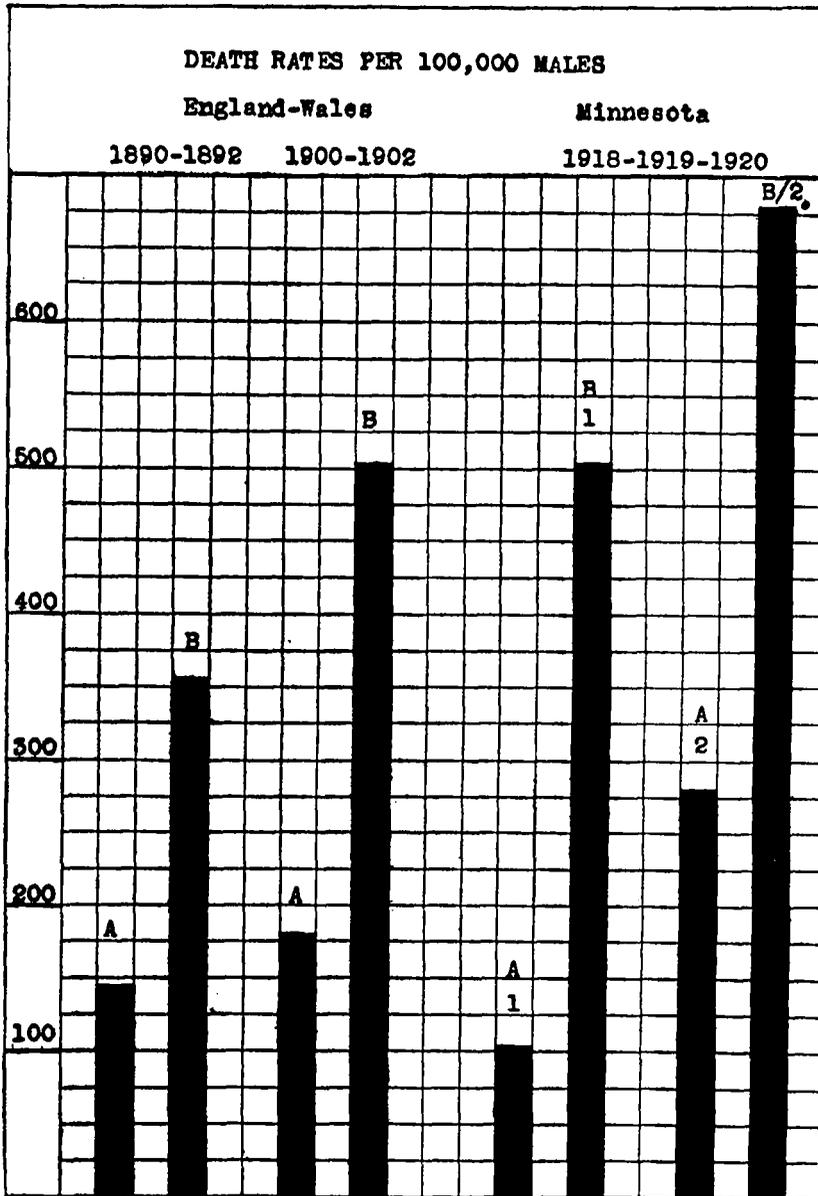


CHART 1. Columns lettered A denote occupied; B, not occupied; columns not numbered denote those thirty-five years of age and over; numbered 1, twenty-one years of age and over; 2, forty-five years of age and over.

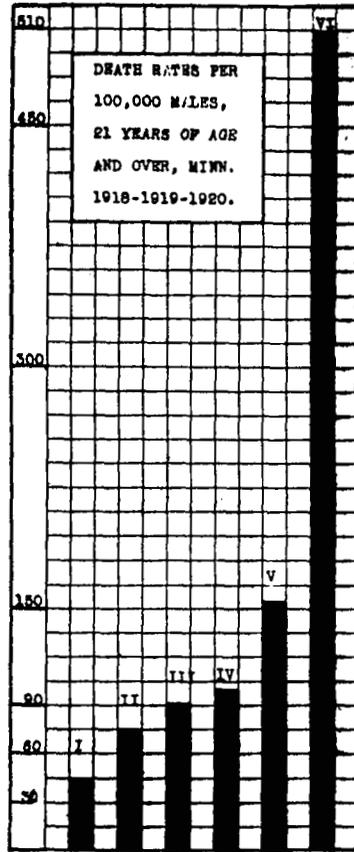


CHART 2. COLUMNS NUMBERED I, II, ETC., REFER TO OCCUPATION GROUPS 1, 2, ETC.

TABLE 1

Death rates per 100,000 males, twenty-one years of age and over, Minnesota, 1918, 1919, 1920

GROUP	NUMBER OF PERSONS	DEATHS	DEATH RATE
1	46,736	20.0	43.0
2	168,460	128.0	75.8
3	84,523	77.0	91.1
4	211,824	213.9	100.8
5	170,483	267.7	156.6
1,2,3,4,5	682,026	706.4	103.5
6	64,503	330.0	510.0

B. Those forty-five to sixty-four years of age. The ratios existing are I:II:III:IV:V::1:1.8:2.1:2.0:2.0 (see chart 4, table 3).

C. In those sixty-five years of age and over we have found the difference less striking as might be expected for this age class, the ratios being: I:II:III:IV:V::1:1.5:1.1:1.4:1.9 (see table 4, chart 5).

D. Considering those of another age class, from twenty-one to sixty-four years of age, we find there is progressive increase in death rate with progressive diminution in amount of necessary muscular activity. The ratios may be expressed: I:II:III:IV:V::1:1.6:2.3:2.4:3.1 (see table 5, chart 6).

In all the age classes considered the death rate from carcinoma among those actively engaged in a gainful occupation is roughly inversely proportional to the amount of muscular activity necessary to that occupation. The only out and out exception to the rule is in group 5, the farmers, for which we lack a satisfactory explanation except that the seasonal character of the occupation in Minnesota may have a bearing, in that during the spring and fall seasons the work is very heavy, while in the winter and summer, especially in winter, the work is very light.

The experience of the Industrial Department of the Metropolitan Life Insurance Company (13) discloses that cancer causes the following percentage of total deaths for the following occupations:

Group 1. Blacksmiths 7.6 per cent; miners 4.6; moulders 3.9; average for the group 5.9 per cent.

Group 2. Laborers 5.5; longshoremen 4.3; machinists 4.5; masons 6.5; average 5.2 per cent.

Group 3: Teamsters 3.6; printers 2.7; painters 4.1; track laborers 4.7; average 3.8 per cent.

Group 4. Clerks 3.1; cigarmakers 5.2; average 4.2 per cent.

Group 5. Farmers 7.6 per cent.

The above figures do not indicate any direct influence of the occupational disease factor.

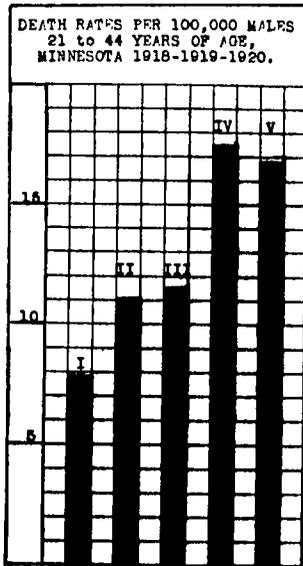


CHART 3

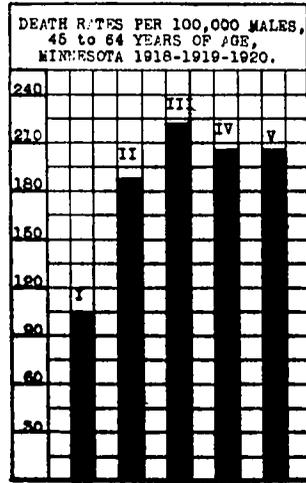


CHART 4

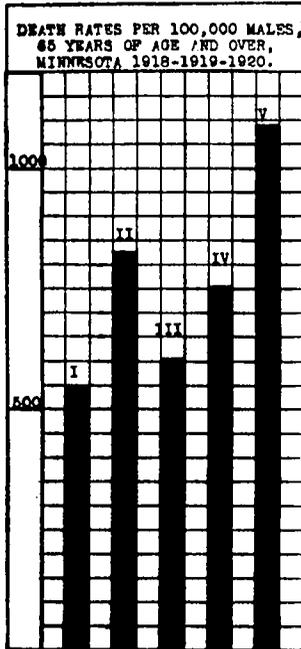


CHART 5

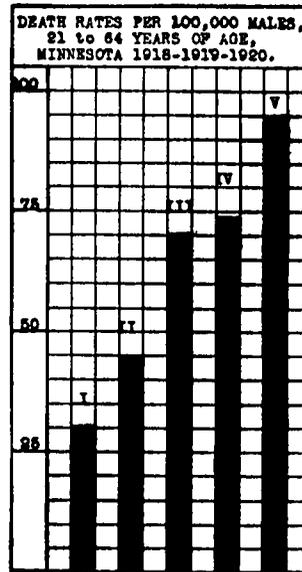


CHART 6

CHART 3. COLUMNS NUMBERED I, II, ETC., REFER TO GROUPS 1, 2, ETC.

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CHART 5. COLUMNS NUMBERED I, II, ETC., REFER TO GROUPS 1, 2, ETC.

CHART 6. COLUMNS NUMBERED I, II, ETC., REFER TO GROUPS 1, 2, ETC.

TABLE 2

Death rates per 100,000 males engaged, twenty-one to forty-four years of age, Minnesota 1918, 1919, 1920

GROUP	NUMBER OF PERSONS	DEATHS	DEATH RATE
1	34,587	2.7	7.8
2	128,233	14.3	11.1
3	58,362	6.7	11.5
4	141,902	24.7	17.4
5	93,661	15.7	16.7

TABLE 3

Death rates per 100,000 males engaged, forty-five to sixty-four years of age, Minnesota, 1918, 1919, 1920

GROUPS	NUMBER OF PERSONS	DEATHS	DEATH RATE
1	11,057	11.3	102.2
2	4,373	65.3	189.9
3	22,955	51.0	221.1
4	61,321	126.0	205.5
5	66,168	136.0	205.5

TABLE 4

Death rates per 100,000 males engaged, sixty-five years of age and over, Minnesota, 1918, 1919, 1920

GROUPS	NUMBER OF PERSONS	DEATHS	DEATH RATE
1	1,092	6.0	549.4
2	5,854	48.3	825.0
3	3,206	19.3	602.0
4	8,601	65.0	755.7
5	10,654	115.7	1085.0

TABLE 5

Death rates per 100,000 males engaged, twenty-one to sixty-four years of age, Minnesota, 1918, 1919, 1920

GROUPS	NUMBER OF PERSONS	DEATHS	DEATH RATE
1	45,644	14.0	30.6
2	162,606	79.7	49.0
3	81,317	57.7	70.9
4	203,223	148.7	73.1
5	159,829	151.7	94.9

A tabulation of the ages at death in the different occupation groups discloses a rather close approximation of extremes and averages so it appears the differences in death rates shown above can not be wholly explained on a basis of age incidence; that is, there is not sufficient difference between the ages of those in the different occupation groups to explain the ratios found to exist between the death rates in the various groups of occupations (see table 6).

TABLE 6
Ages at death, males, Minnesota, 1918, 1919, 1920

GROUPS	NUMBER OF DEATHS	EXTREMES	AVERAGE AGE AT DEATH
1	67	24-81	57.3
2	379	29-91	60.3
3	201	29-83	57.7
4	667	24-88	56.8
5	878	25-90	62.2
6	984	27-103	70.4

SUMMARY

In a preliminary report attention is called to a new factor in carcinoma etiology. Carcinoma has been frequently observed in retired farmers, seldom in active individuals. Precancerous patients have improved clinically with increased muscular activity. Attention is called to observations of less carcinoma among those of necessity physically active. The reported incidence among domesticated animals is greater than in wild animals. A working hypothesis is advanced: That human carcinoma may be the reaction to and the result of chronic irritation of adult epithelial tissue bathed in body fluids altered by certain metabolic products as a result of deficient muscular activity. From a study of carcinoma deaths among males in Minnesota for three years it appears that the death rate in those who are active is greatly exceeded by the death rate in those who are inactive. From a study of the death rates of those who are actively engaged in a gainful occupation it appears that the death rate is lowest in those occupations involving the greatest amounts of necessary muscular activity, and is highest in those occupations involving the least amounts of muscular activity. The age

incidence factor of the cases studied does not explain the variations shown. The figures from the experience of the Metropolitan Life Insurance Company do not show any marked influence of occupational disease on carcinoma death rate. Additional study and accumulation of data are necessary to establish definitely the status of the relation of muscular activity to carcinoma.

CONCLUSIONS

1. Carcinoma constitutes a serious menace to the adults of all civilized races.
2. It appears that the recent increase has accompanied the advent of the Age of Machinery.
3. The reported incidence among the lower animals appears inversely proportional to the degree of muscular activity necessary to the existence of the animal.
4. The death rate in males actively engaged in a gainful occupation is less than the death rate in those not actively engaged in any gainful occupation.
5. The death rate among males actively engaged in a gainful occupation is inversely proportional to the degree of muscular activity necessary for that occupation.
6. A new factor in carcinoma etiology is proposed.
7. A working hypothesis is suggested.

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