EPIDEMIOLOGY OF CANCER OF THE COLON AND RECTUM

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The close relationship between bowel cancer and other non-infective diseases of the bowel, such as benign tumor, diverticular disease, and appendicitis, indicates that these conditions may have a common or related etiology. Their close association with the refined diet characteristic of economic development suggests that the removal of dietary fiber may be a causative factor. These diseases are all rare in every community examined which exists on a high residue diet, and common in every country where a low residue diet has been adopted. Dietary fiber has been shown to regulate the speed of transit, bulk, and consistency of stools, and together with other dietary factors is probably also responsible for the changes which have been demonstrated in the bacterial flora of feces. It seems likely that carcinogens produced by the action of an abnormal bacterial flora when held for a prolonged period in a concentrated form in contact with the bowel mucosa may account for the high incidence of these diseases in economically developed countries.

IN MOST OF THE WESTERN WORLD TODAY, THE large bowel is, after the bronchi, the next most common site for cancer in men.

The evidence discussed here would suggest that this high incidence of cancer of the bowel may, like that of lung cancer, be a relatively recent development, for both these tumors are still rare in developing countries.

As Higginson[26] has pointed out, the incidence of bowel cancer is related to economic development, and no other form of cancer is so closely linked to the alterations in dietary habits with which this is usually associated.

The rates for cancer of the colon and rectum in men per 100,000 standardized for 35–64 years of age[19] arranged in order of incidence clearly indicate this relationship to economic development (Fig 1). Kampala (Uganda), serving a largely rural African community, is at the bottom of the list.

For most of Africa, incidence rates are not available, but the general rarity of bowel cancer can be judged from its proportion of total cases of cancer recorded.

Table 1 summarizes the frequency of cancer of the colon and rectum in published reports from different countries in Africa together with figures obtained from doctors in up-country hospitals with whom a liaison has been established and from whom regular reports have been received. Four other small series, from Uganda,,[7] Tanzania,[22] Acornhoek, South Africa,[64] and Lambarene,[16] each with a total of less than 300 cases, reported a frequency of large bowel cancer varying from 0.2% to 4.4% of the total. Bremner and Ackerman[6] have recently reported the rarity of large bowel cancer and the extreme rarity of intestinal polyps in Johannesburg Bantu. The most remarkable feature is the low and uniform figure of around 2% obtained from each series, with the single exception of Ilesha (Nigeria).[42] This percentage corresponds to the lowest in the world list (Fig. 1) and would appear to represent the basic minimum incidence of this form of cancer. In contrast to certain other diseases associated with Western civilisation, there is as yet no obvious increase in urban relative to rural communities.

Replies to questionnaires received from 34 up-country government and mission hospitals in rural Africa further indicate the great rarity of cancer of the colon and rectum in developing countries. Twenty-one of these hospitals saw an estimated one case, or no case, of large bowel cancer annually. Six stated it was rare or very rare and in only one hospital were as many as 4 cases seen annually.

The age-adjusted incidence rates (Fig. 1) suggest that in industrialized Western countries, bowel cancer is more than ten times

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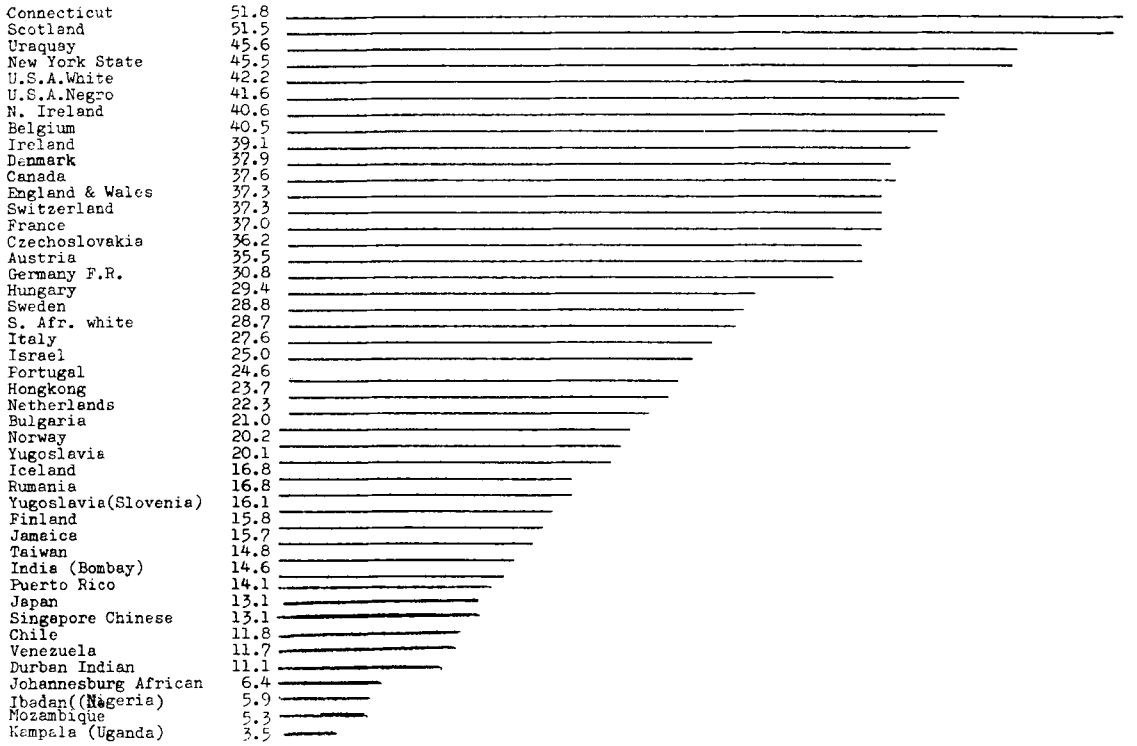

FIG. 1. Age-standardized incidence rates for cancer of the colon and rectum in men 35–64 years of age arranged in order of incidence (modified from Doll[19]).

more common than it is in the African countries listed and, since the frequency in these centres corresponds to that in all other areas investigated in Africa, it can be assumed that a difference of this magnitude exists between Africa as a whole and the industrialized West.

It has been considered advisable to study tumors of the colon and rectum together since many of the variations in relative incidence can be accounted for by tumors near the pelvirectal junction which might be classified in either group. Moreover, as will be discussed below, there are probably common etiological factors.

INCIDENCE CHANGES RESULTANT ON EMIGRATION

The factor which best emphasizes the environmental, rather than the genetic, dependence of bowel cancer is the contrast between the situation in American Negroes, who now have an incidence comparable to that of Caucasians, and that of Africans. Environmental influences are also apparent, although to a lesser extent, in the raised incidence of bowel cancer in the Japanese who have emigrated to America compared with that observed in Japan. Second generation immigrants to California[71] and Hawaii[61] have nearly reached the incidence of their Caucasian compatriots. These migrants have for the most part accepted the dietary customs of their country of adoption, whereas rice has continued to be the basic diet of indigenous Japanese, particularly in rural areas. The rapidly changing dietary pattern in Japan, particularly in urban areas, is being reflected by an increase in large bowel disease.[61]

ASSOCIATION WITH OTHER NON-INFECTIVE DISEASES OF THE BOWEL

Cancer of the colon and rectum is closely associated with other non-infectious disease of the bowel and with hemorrhoids, in geographical distribution, historical rise in incidence, and in individual patients.[8–10]

Similar geographical distribution: Diverticular disease, adenomatous polyps, appendicitis, ulcerative colitis, and hemorrhoids are all rare in those populations in which cancer of the bowel is rare and have their highest incidence in those areas in which bowel cancer is

TABLE 1. Proportion of Cancer of the Colon and Rectum to Total Cancer in Different Parts of Africa

Place	Reported Series: Period	Reported Series: Total Series	Percent of total cancer of colon and rectum	Reference
Johannesburg (S. Africa)	1952–54	1076	2.6	54
do. do.	1962–64	2407	2.4	54
Durban (S. Africa)	1964–66	1040	2.1	55
Lourenço Marques (Mozambique)	1956–60	603	1.3	49
Sudan	1954–61	2234	2.8	38
Accra (Ghana)	1942–55	1192	1.8	21
Kampala (Uganda)	1954–60	615	2.8	15
Nairobi (Kenya)	1957–63	4206	2.5	37
Dakar (Senegal)	1955–64	1838	2.5	13
Salisbury (Rhodesia)	1963–65	1415	1.6	58
Ilesha (Nigeria)	1954–67	465	5.8	42
Stanleyville (Congo Kinshasa)	1939–55	2536	1.1	65
	M. R. C. Survey of Up-Country Hospitals			
	Hospitals			
Kenya	5	934	1.5	
Uganda	7	613	2.1	
Tanzania	23	1743	2.3	
Malawi	22	827	1.7	

most prevalent.[8,44] Large bowel cancer [20] and colon diverticula[33] are, for instance, both three times as common in industrialized Sweden as in more rural Finland. Adenomatous polyps of the bowel are even more rare in Africa than are malignant tumors. Bremner and Ackerman[6] found only 6 in a review of surgical specimens received over 13 years in a 2,000-bed hospital. No polyps were found in a series of 1,000 autopsies in which the bowel had been routinely opened and inspected. Parker and Skinner[6] found no case in over 13,000 autopsies in Rhodesia. Hutt and Templeton[31] reported only 2 in over 40,000 surgical specimens in Uganda, and none in 2,000 autopsies in which the bowel was routinely opened.

Historical appearances: Chronologically, an increase in the incidence of diverticular disease apparently followed the increase in the incidence of bowel cancer. It may be assumed that initially both diverticula and cancer of the large bowel were rare in American Negroes, as they still are in Africans today. Some 30 years ago, much of the gap between the incidence of both these conditions in the Caucasian and Negro population was already partly bridged. Kocour[32] reported that diverticula were only two thirds as common in Negroes as in Caucasians. In 1936, Lawrence[36] reported that both cancer and polyps of the colon were much more common in the Caucasian than in the Negro population. In 1946, Quinland and Cuff,[51] reporting on 300 cases of primary cancer in the Negro, recorded only 10 tumors of the large bowel—8 in the rectum and 2 in the colon. In 1947, cancer of the colon was nearly twice as common in American Caucasians as in Negroes, and rectal cancer was 40% more common.[50] Steiner,[60] surveying a series between 1918 and 1947, also concluded that cancer of the large intestine was considerably less common in the Negro than in the Caucasian.

These racial differences have now almost disappeared in America. In India, the incidence of bowel cancer is significantly higher than in Africa but very much lower than in the Western world. Diverticular disease is still very rare. A possible explanation will be suggested here in relating cancer to changes in both bacterial flora and cellulose deficiency and attributing diverticular disease to gross cellulose deficiency alone. In Puerto Rico, the age-adjusted incidence rates for cancer of the bronchus rose by 117% and for the colon by 95%, between 1950 and 1968. The overall increase for all forms of cancer was 40%.[40] The rise in bronchial carcinoma accompanied an increase in cigarette smoking, and likewise the

rise in colon carcinoma accompanied a progressive adaptation to North American type of diet.

Appendicitis appears at least a generation earlier than the other non-infective bowel diseases associated with Western civilization, just as its age distribution reaches its peak nearly 50 years earlier than that of the other conditions.

Association in individuals—cancer and adenomatous polyps: Strongly positive correlations have been shown between bowel cancer and both adenomatous polyps and villous papillomas. Morson and Bussey[41] consider these benign tumors to be fundamentally part of the same disease, and state that approximately one third of all specimens of bowel removed for cancer have also benign tumors. If the whole of the large bowel could have been examined in each case, the proportion would have almost certainly been considerably higher. Rider et al.[52,53] and Bockus et al.[5] produce abundant evidence of a strongly positive association between benign and malignant tumors of the bowel. Moreover, bowel cancer occurs in nearly half of all patients with familial polyposis.

Cancer and ulcerative colitis: There is a well-recognized association between bowel cancer and ulcerative colitis.

Bowel cancer and hemorrhoids: An association between these conditions has been accepted.

Cancer and appendicitis: Since appendicitis occurs in a much younger age group and is of short duration, an association in the same individuals between this condition and diseases of later adult life would be unlikely even if caused by related factors. Nevertheless, McVay[39] has shown a weak association between bowel cancer and previous appendicectomy.

Investigating the Common Rather Than the Rare

The geographical association between different non-infective bowel diseases, both in their historical appearance and in individual patients, strongly suggests common or related causative factors. It may, of course, be that it is only one or some of many co-factors responsible for these diseases that are related or common. However, this does imply that a successful search for the cause of one of these diseases may provide clues as to the cause of the others, and the more common diseases—appendicitis, adenomatous polyps, and diverticula—provide greater opportunities for investigation than do the rarer partners of the group—cancer and ulcerative colitis.

Association with Diseases Not Affecting Bowel

Not only are there possible leads from the observed association between cancer and other non-malignant diseases of the colon, but clues might also be found from an observed association with other conditions.[9] Communities little influenced by Western customs not only have a very low incidence of non-infective disease of the bowel but also have a low incidence of diabetes, a condition which rises steeply on adoption of Western food and of atherosclerosis which may be attributed to similar dietary habits. These two conditions are closely associated both in geographical distribution and in their tendency to be found concurrently in individual patients. Diabetes and atherosclerosis, like the non-infective diseases of the bowel, have a comparable incidence in American Negroes and Caucasians in contrast to their rarity in rural Africa. Moreover, both these conditions, like the non-infective diseases of the bowel, are relatively rare in Japan, but have increased in incidence in Japanese who have emigrated to the U.S.A.[61] Bowel cancer has also been related to obesity which is closely associated with both diabetes and atherosclerosis.[61,72] Diverticular disease, which has a similar geographical distribution to that of bowel cancer, has been shown to have a strongly positive association with both diabetes and atherosclerosis in individual patients.[56]

Relationship to Diet

It would seem reasonable to assume that the conditions prevailing within the lumen of the bowel are the factors most responsible for the environment of bowel mucosa. However, this does not preclude the possibility of other factors playing a part, such as substances reaching the bowel through the bloodstream.

As has been emphasized, there is a close relationship between bowel cancer and economic development, and the operative factors are probably alterations in dietary patterns. The bridging of the gap between the incidence of non-infective disease in American

Negroes and Caucasians during the last 40 years relates to the lessening of dietary differences. Similarly, the low frequency of about 1% of all malignant tumors given for bowel cancer in Egypt, in 1924,[18] was considered to be related to the then prevailing diet. In contrast, Nasr,[43] nearly half a century later, reported from Cairo a frequency of 6%, a figure three times greater than that pertaining in sub-Saharal Africa. Wynder et al.[72] have, moreover, pointed out that bowel cancer in Japan is more common among those on a more Westernized diet.

Effect of Diet on Intestinal Transit Time, Stool Bulk, and Content

One of the most notable differences between the diet of the Western world where bowel cancer is most prevalent, and that of less-developed communities where it has its lowest incidence, are the proportions of unabsorbable fiber and refined carbohydrate in the food ingested.[14] Reduction in fiber and, therefore, in bulk inevitably results in an increased consumption of refined carbohydrate. Changes in cellulose content of food alter colonic activity, intestinal transit time, and stool bulk and consistency,[66-69] and excess carbohydrate has been shown to alter the bacterial content of the feces.[29]

It is noticeable that the stools of those eating high residue diets are almost invariably bulky, soft, and non-odorous in contrast to the formed and often faceted motions so common in communities eating highly processed food.[14] The relative absence of fetid smell in the stools of people in developing communities and in the stools of wild animals[14] is also significant and is believed to indicate a lower rate of bacterial decomposition compared to that occurring in Western countries.

Following the example of Walker[66,68] in South Africa, I have enlisted the cooperation of workers in many countries in Africa and elsewhere to measure intestinal transit times using the method advocated by Hinton et al.[28] This entails swallowing radiopaque plastic pellets which can be detected in the stools either by x-ray or by washing a stool through a wire mesh.[69] The time the pellets are swallowed and the time each stool is passed are recorded. There is a clear correlation between intestinal transit time and stool bulk, and the fiber content of food. The intestinal transit time and stool weights measured for African villagers, boys in an African boarding school on semi-European type diet, and boys in an English boarding school are shown in Figs. 2 and 3.[11] The effect of diet cellulose on intestinal transit time has also been estimated by Holmgren and Mynors,[30] who gave capsules of carmine to 3 groups of Africans living on unrefined, mixed, and refined diets. The average time that lapsed before the appearance of the dye in the stools in the miners on traditional diet was 14.5 hours. For the African trainee-teachers on a mixed diet, it was 20.6 hours, and for the medical students on a refined diet 28.4 hours.

Measurement of the bacterial flora is much more difficult. Comparisons between English and African stools were made by Aries et al.[3] who compared a group of Londoners with

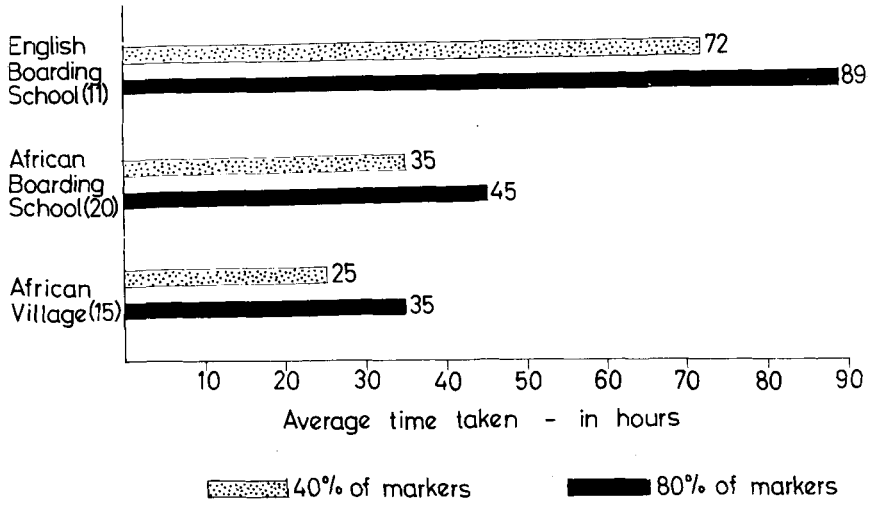

FIG. 2. Effect of diet on intestinal transit time.

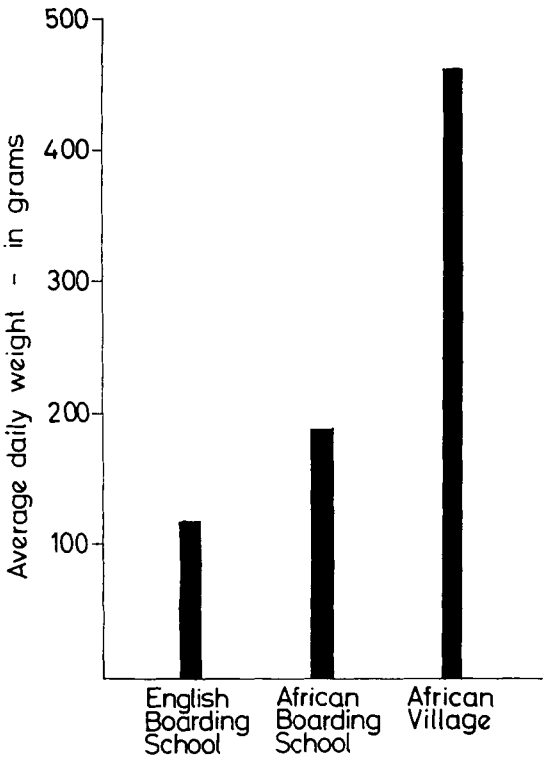

FIG. 3. Effect of diet on stool weight.

some Uganda adults and found the main differences in the increase in bacteroides and bifidobacteria and decrease in streptococci and lactobacilli in the English compared to the Ugandan stools. Hoffman[29] reported a higher bacteria content in volunteers on a high carbohydrate diet than in those on high fat or protein diet.

The rarity of pyelitis in rural Africans, together with the observation that toxemia from gangrenous bowel and the mortality from bowel surgery are both much less in Africans than in Caucasians, certainly suggest differences in intestinal flora between the two groups.

It can be concluded that diet affects intestinal transit time, and the bulk, consistency, and bacterial flora of the feces. It seems almost certain that it also determines intralumen pressures.

Experimentally, it is easy to demonstrate the effect of increased roughage on bowel activity by adding bran to one's diet; not only is this an effective preventative of constipation[63,70] but it has been found therapeutically effective for relieving the symptoms of piles[17] and diverticular disease, which is now believed to result from the high pressures associated with low residue diet.[46,47]

BOWEL CANCER RELATED TO FECAL CONTENT

Anatomical distribution: The fact that most non-infective diseases of the large bowel have their greatest incidence in the segment of bowel in which both fecal arrest and bacterial proliferation are maximum suggests a relationship between these diseases and bowel content.

Absence of tumors in short-circuited bowel loop: The former concept that the pelvic colon was a reservoir for feces, while the rectum remained empty, has been challenged by Halls[25] who has shown that the rectum is not normally empty. The close epidemiologic association between cancer of the colon and rectum increases the suspicion that retained feces may be etiologically related to these tumors.

The evidence that a loop of bowel short-circuited from the stream of feces remains free of tumors induced experimentally in other parts of the intestine supports this concept.[59]

Rarity of tumors in other body canals: Of all the epithelial-lined channels of the body, only the bowel and the bronchi are highly prone to malignant change. These are also the only ones in which the content can be readily controlled. The large bowel is unique in its high bacterial content. Tumors of the ureter, urethra, common bile ducts, or salivary gland ducts are exceedingly rare, and there is no evidence that the incidence varies in different communities.

Rarity in primitive communities and animals: A further factor which suggests that alterations in diet may be responsible for increase in bowel cancer is its rarity, not only in all communities living on relatively unprocessed food, but also in all animals.

RELATED CAUSATIVE FACTORS IN CANCER AND OTHER NON-INFECTIVE DISEASES OF THE LARGE BOWEL

Malignant and benign tumors: The following evidence indicates that both bowel cancer and adenomatous polyps must have a closely related or common cause.

1. They are closely associated both epidemiologically[8-10] and in individuals.[5,41,53]
2. They have a similar anatomical distribution in the large bowel.
3. They have a similar age distribution ex-

cept that there is approximately a 5-year shift to the left for benign, compared with malignant tumors.

4. They can both be produced experimentally by the same procedures.[41,71,72]

5. The sex distribution with a 3:2 female preponderance is the same for each condition.[4]

6. The fact that at least 3.5% of patients who have had colon or rectal cancer removed surgically will develop a second primary growth, and the observation that the chance of a further primary tumor developing is doubled if polyps are associated with the cancer at the first operation[41] suggests a factor acting generally on the bowel mucosa to produce either benign or malignant tumors.

7. The very high risk of colon cancer developing in patients with familial polyposis suggests that some hereditary factor may render affected individuals particularly susceptible to a common factor responsible for both diseases. The observation that both the benign and malignant tumors in these patients tend to occur at an earlier age than usual with these lesions, supports this contention. Morson and Bussey[41] state "the experimental evidence to date suggests only that there is a common factor in the aetiology of adenomas and carcinoma not that carcinomas are usually or always preceded by a benign lesion."

Cancer and ulcerative colitis: These conditions are closely associated in their geographical distribution.

They are closely associated in individuals, patients with ulcerative colitis having a greatly increased risk of developing bowel cancer. It seems more reasonable to postulate associated factors than a cause and effect relationship, as it is very rare for an inflammatory process to give rise to malignant change. For example, there is no evidence that chronic bowel ulcers caused by schistosomiasis or amoebiasis predispose to bowel cancer. It may be that some factor responsible for both conditions is operating with undue intensity or on a particularly susceptible patient.

Cancer and diverticula: The close epidemiologic association is the strongest argument for a related causative factor.

Cancer and hemorrhoids: It is much more likely that both conditions are the result of common or related causative factors than that hemorrhoids are the result of cancer. Although the former have a positive association with the latter, the vast majority of patients with hemorrhoids never develop bowel cancer.

Bacterial Changes in Feces in Inducing Tumors of Large Bowel

Small bowel exemption: Epithelial tumors are very rare in the small intestine which has a much lower bacterial content than the colon.

Cancer suppressed in germ-free rats: Cole[72] showed that a carcinogen capable of inducing bowel cancer in normal rats produced no tumore in germ-free animals. Stewart[62] confirms this evidence, reporting that cycasin given by mouth produces tumors, chiefly in the colon, in experimental animals, but does not have this effect if fed to germ-free rats. He interprets the observation that nearly all the ingested cycasin can be recovered from the urine and feces in germ-free rats and only 15–35% of it from normal rats as an indication that it is broken down in the bowel by bacteria with production of carcinogens.

Bile salts in stools: It has been postulated that altered bacterial flora may lead to degradation of bile salts with resultant formation of carcinogens.[71]

Hill et al.[27] believe that there are less bile salts in stools from Africa compared with England but have shown that stools from Western communities, where bowel cancer is common, contained more bacteria capable of causing degradation of bile salts than did stools from Indians and Africans. They have also shown that there are more products of bile degradation in Western stools than in stools from regions where bowel cancer is rare. They blame increased consumption of fat rather than of refined carbohydrates. In this connection, it is of interest that the total per capita increase in consumption of fats in the U.S.A. between 1909 and 1961 rose only 12%, and the increase in saturated fatty acids was only 7%. The increase in the consumption of sugars and syrups over the same period was 218%.[1] Moreover, bowel cancer tends to be more common in urban than in rural communities, although the latter usually have a higher fat consumption.

It seems likely that bacterial changes will be accepted as probable causative factors in bowel cancer, though the reason for the bacterial changes may be disputed.

A number of bile acids have, in fact, been shown to be carcinogenic. Lacassagne et al.[34] showed that apocholic acid, a product of mild dehydration of cholic acid, one of the two main bile acids, could definitely be carcino-

genic. Later,[35] they reported the sarcomagenic activity of a product of the artificial oxidative degradation of bile acids.

Haddow[24] has stated that "the recognition . . . of the nature of the steroid skeleton . . . at once suggested the possibility . . . of the formation of small amounts of potent carcinogens within the body from such naturally occurring molecules as the bile acids." He had previously reported[23] that the bile acid deoxycholic acid could be chemically converted into a potent carcinogen, 3-methylcholanthrene.

Antonis and Bersohn[2] provided further evidence suggesting that this may in fact occur. They showed that the quantity of bile acids in the stools is greater in Africans on a high residue diet than in Europeans on diets with reduced fiber content, which suggests that in the latter group a proportion of the bile acids had been destroyed in the gut. This evidence might suggest that in the case of patients on low residue diet a proportion of the bile acids had been altered, possibly by abnormal or excessive bacterial flora, to products with carcinogenic activity. In keeping with this are the observations referred to above, that the amount of ingested cycasin which can be recovered from the feces is greater in germfree rats without bowel tumors than in normal rats with tumors. The disappearance of part of the cycasin in one case and of the bile salts in the other, in the presence of bacteria, suggests that the latter play a part in the production of carcinogens.

These observations parallel the production of carcinogens formed from cycads which are also believed to depend on bacterial activity as mentioned previously.

Differences in bowel flora: In at least some Africans, bowel flora is different from that of Europeans.[1]

Most chemical compounds which are carcinogens in the gastrointestinal tract produce tumors in the proximal rather than in the distal bowel where bacterial action is maximal.

Facts in Formulating an Hypothesis of Cause of Bowel Cancer

1. The close association both epidemiologically and in individual patients with other non-infective diseases of the bowel.

2. The geographical association between non-infective disease of the bowel and some other conditions, such as diabetes, atherosclerosis, and obesity.

3. The association between diet and bowel behavior and content.

4. The epidemiologic association between non-infective diseases of the bowel and low residue diet.

5. The rarity of epithelial tumors in the small intestine and all other epithelial-lined canals except the bronchi.

6. The role played by bacteria in producing bowel cancer in experimental models.

Suggested Hypothesis

It is a bold move to suggest an explanation for the frequency of large bowel tumors in Western countries, particularly in view of the fact that most cancer is probably multifactoral in origin. It may seem even more daring to suggest a similar cause for such common diseases as appendicitis and diverticular disease, but I am convinced that these diseases must be considered together. The adoption of a refined carbohydrate diet appears the most important, though probably not the only, responsible factor, and this hypothesis is consistent with the clinical, epidemiologic, and experimental evidence.

Diverticular disease: This is easy to explain on the basis of a cellulose-depleted diet.[47,48] Diverticula can be produced in experimental animals fed for prolonged periods on a low-residue diet. A high-residue diet alleviates the disease.

The prevalence of diverticular disease in a community does not appear to rise until sometime after a rise in cancer incidence. Dietary cellulose is usually not significantly depleted until some time after refined carbohydrates, which affect bowel bacterial flora, have been added to the diet.

Appendicitis: There is abundant epidemiologic evidence relating appendicitis to both the removal of fiber from diet[57] and the addition of sugar.[12,14] The former results in raised intralumen pressures in the colon, in general, but particularly in the appendix when blocked with fecoliths which are peculiar to constipated bowels. This may cause devitalization of the mucosa while the excess sugar alters the bacterial flora in the feces which is probably chiefly responsible for the inflammatory process.

Diseases associated with refined carbohydrate: The association between conditions believed to be partly or largely due to low residue diet on the one hand and those believed by many

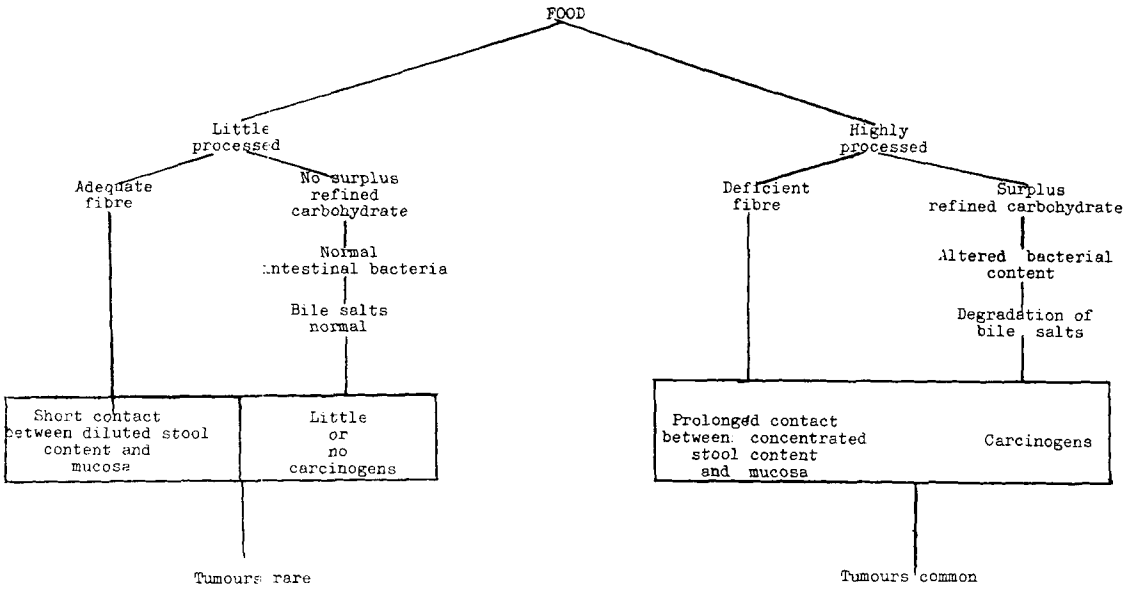

FIG. 4. Diagrammatic representation of possible relationship between diet and cancer of the bowel.

to be due to excess consumption of refined carbohydrates, such as diabetes, atherosclerosis, and obesity on the other, can be readily explained by the fact that removing unabsorbable fiber from carbohydrate foods results in increased consumption of the refined product to satisfy appetite.[10,14] Cleave et al.[14] argue persuasively that these and other diseases are due primarily to refining carbohydrate, and they recommend the inclusive term "Saccharine Disease"* for all the conditions.

Tumors: With regard to benign and malignant tumors, there are at least two ways in which a refined carbohydrate diet could be responsible (Fig. 4).

Any carcinogen ingested or formed in the gut would, in refined carbohydrate eaters, not only be present in a more concentrated form in small stools, but would be held in contact with the mucosa for a prolonged period in a constipated colon.[45,71] An additional factor responsible for retention of stools in the distal colon and rectum in economically developed communities is the social custom which precludes bowel evacuation unless facilities are readily available. Walker et al.[69] have commented on the ability of the African to empty his bowel at will.

The most likely cause of bowel tumors seems to be carcinogens produced by bacterial action on bile salts or other normal bowel constituents. The degradation of bile salts by bacteria could explain the reduced quantity of those salts in people prone to bowel cancer on a Western diet compared to that found in South African Bantu, whose bowel cancer incidence is very low. A hypothesis incriminating both bacterial activity and colonic stasis could account for the anatomical distribution of benign and malignant tumors which are found maximally in the area where fecal retention is most prolonged and bacterial action most pronounced.

CONCLUSIONS

All experimental studies in cancer are eventually aimed at limiting or curing the disease. When relationships have been established between environmental factors and the incidence of a particular disease, whether benign or malignant, evasive action can be taken before the actual causative agents or mode of action is understood. Cholera was evaded by the avoidance of sewage-contaminated water a century before the v. cholera was identified as the cause of the disease. Lung cancer can largely be avoided by abstinence from smoking cigarettes, although the carcinogenic mechanism whereby tobacco smoke causes cancer is not yet understood. A relationship can be demon-

* Saccharine, meaning related to sugar, is to be pronounced to rhyme with the river Rhine, to distinguish it from the chemical sweetener.

strated between certain bowel diseases and diet, and although this has not yet been shown to be causative in the case of cancer, the relationship between an over-refined diet and diverticular disease can now be considered established. In view of the evidence, it seems justifiable to issue a warning against the removal of so much of the unabsorbable fiber from our food, and the associated over-ingestion of refined carbohydrates.

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