due to the fact that one constituent of the mixture is acting as a solvent of the other, and solution is only gradual. A series of compounds has been investigated to illustrate this point, and in each case two substances have been chosen whose melting points are fairly close together. The usual type of apparatus was employed in which the bath was sulphuric acid.

A tube containing one pure substance was attached to the left side of the thermometer, the second pure substance to the right side, and a third tube in the middle contained an intimate mixture of equal parts by weight of each substance. The temperature was gradually raised, and the three tubes closely inspected during the process by the aid of a lens. The pure substances retained their original appearance to within about 1° C. of the final fusion point, which in each case was complete within a range of 3° C. The mixture of the two substances taken commenced to soften at a much lower temperature, and fusion extended over a considerable range in each case.

It is clear from the following table that a pair of substances may have similar melting points, but a totally different one when mixed.

Table of Melting Points of Pure and Mixed Substances.

Substance.	Melting Point.	Melting Point of Mixture.
Antipyrin	110°-113°	57°-74°
Antifebrin	110°-113°	
Anisic acid	181°-183°	145°-172°
Succinic acid	187°-188°	
Aconitine	190°-193°	160°-175°
Veronal	190°	
Thymol	50°-51°	18°-30°
p. Toluidine	45°	
Cocaine	96°-98°	63°-95°
p. Chlor-formanilide	100°-103°	
Codein	150°-152°	75°-135°
p. Acet-toluide	150°-152°	
Cinnamic acid	133°-135°	95°-115°
Phenacetin	133°-135°	
Sulphonol	126°-127°	70°-90°
β Naphthol	122°-123°	
Cocaine	96°-98°	60°-85°
Betol	95°	
Strychnine	270°	230°-240°
Cinchonidine	260°	

During the past three years I have had on two occasions to examine specimens of urine for small quantities of abnormal constituents, and in each case succeeded in extracting about 0.1 gram of a crystalline substance closely resembling veronal.*

In both instances the compound was first carefully purified, but the amount of pure material obtained was much too small to be investigated by any known method other than that described. The agreement between the melting points of veronal, the material suspected to be this compound, and a mixture of both, left no doubt as to the identity of the drug.

It is hoped that this application of a simple physical constant may prove of great value to toxicologists.

* The veronal was extracted from the urine with ether after preliminary treatment with lead acetate, etc., according to method described by Fischer and Hoppe (*Muench. med. Woch.*, No. 28, 1909).

THE recently issued report of the Sceptre Life Association, an insurance company which caters for abstainers and non-abstainers and keeps the results attained in each section separate, again shows the effect of total abstinence on the longevity of its policy holders. In 1912, of 132 deaths expected among non-abstainers 92 occurred, whilst there were only 53 out of 139 expected deaths of total abstainers. The percentage of actual to expected deaths among the non-abstaining insured (69.70) was more than double that of the abstaining policy holders, who come out with the low percentage of 38.13. For the twenty-nine years 1884 to 1912 the percentage of actual to expected deaths has been, for non-abstainers, 79.33; for abstainers, 51.68. Seeing that at the time of acceptance each class of policy holders was examined as rigidly as the others and all the lame ducks cast out, the results recorded must be regarded as evidence that the use of alcoholic liquors shortens the duration of even picked lives.

THE INTRAMURAL SPREAD OF RECTAL CARCINOMA.

[WITH SPECIAL PLATE.]

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OPERATIVE measures for the eradication of cancer must be planned according to the pathological findings. That widely divergent views are held as to the particular operative treatment applicable to cancer of the rectum and pelvic colon is sufficiently evidenced by recent papers on the subject by Harrison Cripps, Paul, Miles, and Sampson Handley. It may reasonably be assumed that corresponding differences of opinion exist as to the pathological conditions which obtain; and, indeed, such assumption is amply confirmed by the perusal of these papers, as well as by the remarks made by speakers during the discussion on rectal cancer at the Royal Society of Medicine in 1910.

A convenient classification—adopted by Miles—of the pathological factors which must be considered in planning any radical operation for cancer of the rectum is as follows: (1) The spread of the disease in the bowel wall—intramural; and (2) that which occurs in surrounding or distant tissues—extramural.

This communication is concerned with the first factor, and an attempt has been made to determine its extent and significance.

Material.

This comprises 20 cases, in 18 of which the bowel investigated was removed by operation. Two *post-mortem* cases are included because they exhibit important features. The majority of these cases were operated on by surgeons at the Cancer Hospital, but for three I am indebted to Mr. Barker of University College Hospital, and for two to Mr. Gordon Taylor of the Middlesex Hospital. The operation in 13 cases was the radical abdomino-perineal, as described by Miles. In 3 cases the malignant disease was situated above the pelvic colon. The length of bowel removed in these 16 cases was from 9 in. to 23 in. In 2 cases a local resection was practised.

Technique.

The bowel was slit up immediately after operation, stretched by nailing to a piece of board, and placed in a fixative solution consisting either of formalin in normal saline or acid mercury perchloride. After fixation a strip the whole length of the bowel was taken and cut into inches. Each inch of tissue was embedded in paraffin, sectioned, and stained with muci-carmin according to the method which I have elsewhere detailed. In some cases two strips were taken.

Nature of Growth.

The growth in every case was an adeno-carcinoma. In 18 cases the appearance presented was that of a typical carcinomatous ulcer, in 1 there was a tendency to mass formation approximating to the papilliferous form, while 1 exhibited a diffuse colloid infiltration. The last specimen was obtained *post-mortem* from a male patient, aged 18, who rapidly succumbed, and illustrates the extreme malignancy of this form of growth.

The ulcers presented the usual features. Their edges were irregular, rolled, and everted. The long axis of the ulcer was transverse in every case, showing a tendency to involve the bowel circularly rather than longitudinally. Another point noted with regard to these ulcers was the frequency with which a narrow tract of mucous membrane was found to be involved in cases where clinical examination suggested that the ulcer had completely encircled the bowel. This narrow tract of apparently normal mucous membrane was always situated in the mid-line posteriorly. Examination of other specimens, preserved in the museum of the Cancer Hospital, indicates that this condition is so common as to be almost characteristic. The favourite site of origin of cancer of the rectum would appear to be on the anterior or lateral wall. From this point the growth spreads round the bowel, a partial

indication of its progress being afforded by ulceration, which begins to occur at a very early stage.

Spread and Ulceration.

Microscopical examination throws some light on this process of ulceration.

It is assumed that carcinoma commences as a down-growth of glandular epithelium which pierces the muscularis mucosa and invades the submucous coat. The initial carcinomatous focus will be covered by unbroken epithelium, and surface ulceration may thereafter take place, as the growth spreads, by two possible methods.

The growth of carcinoma in the submucous and deeper layers of the bowel wall may undermine the glandular epithelium, cut off its blood supply, and so induce necrosis, thereby exposing the subjacent carcinoma as the base of the ulcer.

On the other hand, successive portions of mucous membrane may be undermined as the growth progresses, and the overlying mucous membrane may be directly involved by upgrowths of carcinoma into and replacing it. The latter process appears to be that which obtains, and the phenomenon is exhibited in Fig. 1.

It will be gathered that the carcinoma spreads more widely in the submucous coat than is indicated by the surface ulceration. The muscular coat is invaded to an equal, and frequently to a greater, extent.

The relative invasion of the various layers of the bowel wall in a typical case may be represented diagrammatically as in Fig. 2.

Fig. 2.

The tendency of the stroma of the growth is to progressive contraction, and the pull thereby communicated to the deeper layers of the adjacent, but uninvolved, bowel wall produces that eversion of the margins of the ulcer which is such a marked feature of these growths. Eversion of the edges of malignant ulcers in other situations may equally be a surface indication of subjacent infiltration greater in extent than the area of ulceration. Puckering of the peritoneum is another phenomenon due to the contraction of the stroma, and it is possible that the first stage of invagination may be brought about by the same means.

Invagination is frequently observed in those cases in which the greater part of the circumference of the bowel is involved and causes the growth to assume the form, when examined per rectum, of a cervix-like mass protruding downward into the lumen of the bowel. The contracting stroma of a carcinoma will exert a pull equally on the bowel above and below. The pull will, however, only be effective on the upper and more movable section, which will therefore tend to be dragged down, and this invaginating process, once commenced, will be continued and increased by peristalsis.

The tendency displayed by carcinomatous growth to encircle the bowel has been already noted. This mode of progress has been rather vaguely ascribed to the circular disposition of the vessels. The main lymphatic networks of the large bowel are: (1) The submucous; (2) the subserous; (3) an intermuscular plexus situated between the muscular layers; and two subsidiary intramuscular networks constituting (4) the plexus of the circular coat, and (5) the plexus of the longitudinal coat.

The lymph from the intramuscular networks drains for the most part into the intermuscular plexus, though communication no doubt exists between the lymph vessels of the longitudinal coat and those of the subserous plexus.

The vessels of the circular muscle coat are disposed radially, running out from the submucous coat to the intermuscular plexus like the spokes of a wheel. This arrangement is illustrated in Fig. 3, drawn from a case of

lymphosarcoma. The vessels of the longitudinal coat have generally a longitudinal direction.

Examination of sections reveals the presence of an important vascular area situated between the two muscular tunics. The vessels of this intermuscular plexus have generally a circular disposition. The importance of this plexus becomes increasingly great as the bowel is traced down until, below the peritoneal reflection, it shares with the submucous plexus the task of transferring the lymph from the bowel wall to the collecting trunks.

Deposits of carcinoma in this intermuscular lymphatic plexus are depicted in Fig. 4, and it is suggested that this plexus is largely responsible for the circular distribution of carcinomatous growths.

Collecting trunks are formed on the posterior aspect of the bowel, those from the rectum draining either into the ano-rectal glands situated within the fascia propria or into the mesocolic glands lying between the layers of the mesocolon.

It is suggestive that the area of uninvolved mucous membrane, previously noted, should occur also on the posterior aspect of the gut at the site where the collecting trunks are in process of formation.

The lymphatic distribution below the peritoneal reflection is diagrammatically represented in Fig. 5.

Fig. 5.—A, Mucous layer; B, submucous layer; C, circular muscle; D, longitudinal muscle; E, ano-rectal gland; F, fascia propria.

One *post-mortem* specimen included in this series is preserved in the museum of the Cancer Hospital. It exhibits a small malignant ulcer the size of a sixpence situated in the mid-line on the posterior aspect of the bowel. Microscopical examination shows that the growth has spread through the whole thickness of the bowel wall, and has freely invaded the connective tissue and glands of the mesocolon. The specimen conclusively illustrates that the size of the ulcer is no measure of the intramural invasion or extramural spread.

The observations hitherto have been concerned solely with the purely local phenomena of intramural growth. In 19 cases no evidence of permeation could be detected beyond the microscopical edge of the growth.

In the remaining case—that of the patient with rapidly growing colloid carcinoma—extensive intramural spread was noted. Every part of the growth stained brilliantly with muci-carmin, so that the condition of the various layers could be easily ascertained (Fig. 6). Sections taken from the bowel wall 14 in. above the growth exhibit much the same appearance. The spread seems to have taken place primarily by means of the subserous lymphatic plexus, involving the longitudinal muscle coat, invading the intermuscular lymphatic plexus, and thence radiating towards the lumen of the bowel. The mucous membrane, though atrophied, shows no evidence of permeation or infiltration, and, although occasional deposits are present in the submucous coat, these only occur in the lower sections.

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Fig. 1.—Direct invasion of mucous membrane by upgrowths from the submucous and deeper layers of the bowel wall.

Fig. 4.—Intramural spread along the intermuscular lymphatic plexus.

Fig. 7.—Deposit of carcinoma in the connective tissue in close proximity to the bowel wall, at a point three inches above the upper limit of the growth.

Fig. 3.—Growth is seen spreading along the radial lymphatics of the circular muscle coat.

Fig. 6.—Intramural spread along the subperitoneal and intermuscular lymphatic plexuses. The growth is spreading along the radial lymphatics of the circular coat towards the submucous coat. The mucous membrane is atrophic.

It has been suggested that local recurrence after local excision is strong evidence in favour of the presence of intramural permeation, even though such be undemonstrable.

That a typical carcinomatous ulcer may be formed as a result of invasion of the bowel wall from without is demonstrated by a case in this series.

On opening the abdomen, it was noted that the pelvic colon was densely adherent to the anterior and left lateral surface of the rectum at the bottom of Douglas's pouch. Separation from the uterus was regarded as an unsafe procedure, so this organ was also removed. On examination of the 12 in. of excised bowel the presence of two growths was revealed, though only one had been diagnosed. These were located on the bowel walls at the site of adhesion. The upper growth, in the pelvic colon, was of the whipcord type, and had completely encircled and constricted the bowel wall, giving rise to the symptoms of obstruction for which the patient was admitted to hospital. The lower growth, in the rectum, presented itself as a carcinomatous ulcer involving the anterior and left lateral walls of the bowel. It is difficult to escape the conclusion that the upper was the older growth and that the lower one had arisen as a result of contact.

In Fig. 7 is depicted a carcinomatous deposit in the pericolic connective tissue 3 in. above the upper margin of a growth. If in such a case a local excision had been practised with the removal of 1 in. of normal bowel above and below the growth, this deposit must necessarily have been left in close proximity to the intestinal junction. Local recurrence in such a case is readily explained. Clinical and *post-mortem* evidence also favours the view that recurrence is an extramural phenomenon.

Finally, it may be stated that in every case in the series the growth had spread to the tissues outside the bowel wall.

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DISLOCATION OF THE METATARSUS, WITH AN ACCOUNT OF THREE CASES.

[WITH SPECIAL PLATE.]

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FREQUENCY OF THE CONDITION.

DISLOCATION at the Lisfranc (tarsal-metatarsal) joint is an unusual form of injury, but it is probably much less rare than would be suggested by a consideration of the meagre literature on the subject. The comparative dearth of references in surgical literature may be realized when the figures given by Stimson in his treatise on fractures and dislocations are quoted:¹ "Malgaigne collected 21 cases of the various dislocations, Hitzig 29, Bayer 68, and Fischer 18 of the first metatarsal." Panse, quoted by Nasse and Borchardt, in the *Handbuch der praktischen Chirurgie* (Bergmann, Bruns, and Mikulicz),² "was able to collect, in the year 1897, 22 complete and 23 partial dislocations."

Considering the exposure of the foot to violence, these figures are undoubtedly small, and give almost certainly a false idea of the actual frequency of such a type of injury.

DEARTH OF RECORDS.

The relative dearth of records may in part be explained by the fact that minor degrees of displacement have been overlooked. The development of radiography in recent years ought to act now as an effective preventive of this type of error. Part explanation may also be found in the fact that the existence of these dislocations might readily be overlooked when they form mere incidents in a more severe injury to the foot and ankle, perhaps calling for immediate amputation.

Indeed, another aspect of this possibility is suggested by the fact that several writers of repute have put it on record

that these dislocations, when they do occur, are usually the result of crushing force of such severity as to destroy the vitality of the soft parts to a degree which renders amputation necessary.

Thus Griffith³ says they are usually "complicated by destruction of the soft parts, and frequently require amputation"; Wharton⁴ says, "These dislocations usually result from crushing forces which destroy the vitality of the soft parts so completely that amputation is required"; and even Erichsen⁵ states, "The question of amputation will always present itself in these cases, and must be determined on general principles, by the age of the patient, and by the extent of injury to the soft parts."

It is probable that such dislocations are neither so uncommon, nor, as regards the prognosis, of so grave a nature as the records and opinions referred to above would imply.

The varieties of dislocation are as follows:

1. Dislocations of single metatarsal bones.
2. Dislocations of several metatarsal bones simultaneously.
3. Dislocations of the whole metatarsus *en bloc*.

Any of these forms may be, and the second and third usually are, complicated by other injury, such as fracture, accompanying damage to the cuneiform bones or cuboid, with or without displacement, or damage to soft parts.

In Group 1 the first metatarsal seems to be by far the most commonly dislocated. In the cases reported it was almost always displaced upwards. As already quoted, Fischer⁶ was able to collect records of 18 cases of this injury. The recorded cases of isolated dislocation of the other metatarsals are very few in number.

In Group 2 cases have been recorded of quite a number of different combinations. In groups of two at a time there are records of the first and second being displaced together; also the third and fourth, and the fourth and fifth. The direction of displacement varied in each—sometimes upwards and inwards, at other times upwards and backwards. In groups of three at a time, there are records of 2 cases of dislocation of the first, second, and third metatarsals, these being displaced together upon the dorsum; in 1 case the displacement was downwards into the sole. The second, third, and fourth have been, in one or two cases, displaced together upon the dorsum.

Of dislocations of four metatarsals at a time, 4 cases are mentioned by Stimson, all having been dislocations of the first four metatarsals. In two of these the affected bones were displaced bodily upwards. In 1 case (reported by Malgaigne) the first three were displaced downward, and the fourth upward. In one (reported by Ely⁷) the first metatarsal was displaced inwards, the others upwards and outwards. This case of Ely's, it will be seen later on, seems to have been very similar to one of the three cases which I have to report in this paper.

Group 3 comprises those cases in which all the metatarsal bones have been displaced bodily at the tarsal-metatarsal joint.

Four forms have been described, according as the displacement was upward, outward, downward, or inward. Only one example of each of the two last-mentioned forms has been reported, and one, the inward form, is not free from doubt as to its correct description. The case of downward displacement was reported by Smyly.⁸ The injury was caused by the fall of a wagon which pressed the heel forward, while the toes were fixed.

Even the upward and outward displacements have not been met with, or recognized, with any degree of frequency. Hitzig, quoted by Stimson, gives the number of cases of upward dislocation he was able to collect as 11, the most usual cause being direct violence, but in 2 cases muscular violence was the agent, the patients sustaining the injury in making violent effort "to avoid falling, after having slipped while carrying heavy bundles."

This form of dislocation may be complete or incomplete, and it may be complicated by a part or the whole of one or more of the cuneiforms being displaced along with the metatarsals. Examination has shown in those cases examined *post mortem*, or where the injury was compound, just such damage—in the way of rupture of dorsal and plantar ligaments and of muscles, in the fracture or separation of cuboid and cuneiform bones, and in the fracture of one or more of the displaced metatarsals, or