The Journal of the American Medical Association

Published under the Auspices of the Board of Trustees

VOL. XLIII.

CHICAGO, ILLINOIS, SEPTEMBER 10, 1904.

No. 11.

Original Articles.

THE PELVIC URETERAL SHEATH.

ITS RELATION TO THE EXTENSION OF CARCINOMA CERVICIS UTERI.*

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During the last year and a half I have been studying the extension of carcinoma cervicis uteri with special reference to its bearing on the more radical operations for that disease. These studies¹ have demanded a knowledge of the anatomy and physiology of the neighboring structures, of how the disease invades these parts, and especially the effect of the more radical operations on such organs as the bladder, ureters, rectum and other pelvic structures.

In studying cross sections of the parametrium of those cases in which the lower ends of the ureters have been resected in order to obtain a wide excision of the primary growth, an opportunity was afforded not only of determining how the growth invaded the parametrium, but also its relation to the ureters. In these cases it was noticed that the ureters were inclosed in a sheath which seemed to be derived from the tissue along or through which the ureters pass, and served as a protection to the ureters from the invasion of the carcinomatous growth.

Waldeyer² has called attention to the fact that there is pictured in Krause's anatomy, longitudinal muscular bundles which extend from the bladder up on the ureter, but the cut is not accompanied by any description. He describes them as longitudinal muscular bundles, which are united to each other by connective tissue and separated

from the ureter by a space which can be injected. This sheath has a thickness of .5 to .75 mm., and he says extends from 3 to 4 cm. up along the ureter. The lumen he considers to be a lymph space.

Disse³ refers to Waldeyer's sheath, and says that these muscular bundles, which are greatly hypertrophied, do not come from the bladder, as they appear to do, but from the ureter, and suggests that their hypertrophied condition, as well as the space between them and the ureter, arises from the contractions of the bladder pulling on the outer ureteral coat.

If the abdominal portion of the ureter is exposed at autopsy and partially freed from its surrounding tissue and traction made on it, it can be drawn out from what is apparently a sheath, which seems to be a part of the subperitoneal connective tissue, and is continuous with that surrounding the kidney above and accompanying the ureter into the pelvis below. Cross sections of the abdominal portion of the ureter, with its surrounding tissue, show that the ureter lies in the subperitoneal adipose and fibrous tissue, and that this tissue forms a very imperfect and rather indefinite sheath about the ureter, and it usually requires some play of the imagination to make out a definite ureteral sheath from cross sections of the abdominal portion of the ureter. If the dissection is carried down into the pelvis, this apparent ureteral sheath becomes more definite, so much so that it may be split open and the ureter shelled out from it. On reaching the bladder the lower end of the ureter seems to be reinforced by muscle bundles extending from the bladder up along the ureter, and which have been referred to.

On stripping the peritoneum from the side of the pelvis it will be noticed that the portion of the ureter above the parametrium may be carried down with the peritoneal flap thus formed. This portion of the ureter will be referred to as the subperitoneal portion, while that below the entrance of the ureter into the parametrium may be called the parametrial portion of the ureter.

Cross sections of the subperitoneal portion of the ureter show that it is surrounded by a fibrous sheath which is derived from the tissue along or through which the ureter passes, and here is adherent to the peritoneum; on that account the ureter, with its sheath, may be dissected away from the walls of the pelvis with the peritoneum. This is shown in Figure 1, which represents a cross section of the ureter taken about 1.5 cm. above its entrance into the parametrium. This sheath is better developed in some cases than in others, and by cross sections one may follow it above the brim of the pelvis in one case, while in another case the sheath around the entire subperitoneal portion of the ureter may be poorly developed. Cross sections of the parametrial portion of the ureter show how the sheath accompanies the ureter

* Read at the Fifty-fifth Annual Session of the American Medical Association, in the Section on Pathology and Physiology, and approved for publication by the Executive Committee: Drs. V. C. Vaughan, Frank B. Wynn and Joseph McFarland.

1. Sampson: The Importance of a More Radical Operation in Carcinoma Cervicis Uteri, as Suggested by Pathological Findings in the Parametrium. Johns Hopkins Hospital Bulletin, 1902, xiii, 299-307. Also: Ascending Renal Infection; with Special Reference to the Reflux of Urine from the Bladder Into the Ureters as an Etiological Factor in Its Causation and Maintenance. Johns Hopkins Hospital Bulletin, 1903, xiv, 334-352. Also: The Efficiency of the Periureteral Arterial Plexus and the Importance of Its Preservation in the More Radical Operations for Carcinoma Cervicis Uteri. Johns Hopkins Hospital Bulletin, 1904, xv, 36-46. Also: The Relation Between Carcinoma Cervicis Uteri and the Ureters, and Its Significance in the More Radical Operations for that Disease. Johns Hopkins Hospital Bulletin, 1904, xv, 73-84. Also: Complications Arising from Freeing the Ureters in the More Radical Operations for Carcinoma Cervicis Uteri, with Special Reference to Post-operative Ureteral Necrosis. Johns Hopkins Hospital Bulletin, 1904, xv, 123-134. Also: The Relation Between Carcinoma Cervicis Uteri and the Bladder, and Its Significance in the More Radical Operations for that Disease. Johns Hopkins Hospital Bulletin, 1904, xv, 156-162.

2. Waldeyer: Ureter-scheide, Verhandlungen der Anatomischen Gesellschaft, 1892, 259-260.

3. Disse: Von Bardeleben, Handbuch der Anatomie, Gustav Fischer, Jena, 1902, vol. vii, No. 1, pp. 107-109.

through the parametrium, or, to express it more correctly, how there is formed about the ureter a sheath from the tissue along or through which the ureter passes, as shown in Figure. 2.

Cross sections of the lower 1 to 2 cm. of the ureter demonstrate that this portion of the ureter is surrounded by muscle bundles which also give rise to a sheath, and which Waldeyer² claims extends up along the ureter for a distance of 3 to 4 cm. In the cases which I have studied the muscular sheath has not extended over 2 cm. above the bladder. Disse³ claims that these muscles arise from the ureter and not from the bladder, as they appear to do. See Figures 3 and 4.

The pelvic portion of the ureter is surrounded by a sheath which is derived from the tissue along or through which it passes. Near the bladder this sheath is composed mostly of muscle fibers. As one examines cross sections higher up, the muscular fibers gradually disappear, and one finds that another sheath appears which fuses with the muscle fibers, encircling the upper ends of them, and is continued above as the fibrous sheath previously referred to. It is difficult to determine the origin of the muscular fibers about the lower end of the ureter. They apparently arise from the bladder, and I

Fig. 1.—Transverse section of ureter with its sheath taken 1.5 cm. above its entrance into the parametrium, $\times 5$. The internal iliac artery was injected one hour after death, with a 15 per cent. solution of gelatin colored with ultramarine blue. The large vessels of the periureteral arterial plexus are shown contrasting with the smaller branches in the walls of the ureter. The inside of the sheath is filled with adipose and fine fibrous tissue in which are imbedded the periureteral vascular plexuses.

think that this is true for some of them; on the other hand, one can see from cross sections taken at different levels that others may arise from the outer coats of the ureter, as Disse³ claims.

The structure of the sheath is dependent on the structure of the tissues along or through which the ureter passes. Near the bladder one finds muscular fibers predominating, while higher up the sheath is composed of fibrous tissue, with an occasional muscle bundle. The thickness of the sheath varies in different places, and in different cases, and is dependent on the tissue about it, as may be seen by referring to the illustrations. The lumen of the sheath is filled with adipose tissue and strands of fibrous tissue and contains the vascular ureteral plexus. One finds in the sections of this sheath empty spaces, which in some instances may be lymph spaces, but in nearly every instance which I have seen appeared more like artefacts. A hypodermic needle may

be inserted along the ureter and colored fluid forced into the tissue about the ureter, and this will follow the course of the ureter, indicating that this sheath restricts

Fig. 2.—Transverse section of ureter with its sheath taken about in the middle of the parametrium, $\times 2\frac{1}{4}$. Transverse section of right parametrium and one-half of the cervix from a specimen of hysterectomy for carcinoma cervicis uteri in which the lower portion of both ureters was sacrificed and the renal ends of the ureters implanted into the bladder. The ureteral sheath is derived from the tissue along or through which the ureter passes, and here consists of fibrous tissue with a few fine muscle bundles at the upper end. Within its walls can be seen the larger vessels of the periureteral vascular plexuses in cross section.

Fig. 3.—Transverse section of ureter with its sheath taken just above the bladder, $\times 2\frac{1}{4}$. From the same specimen from which Figure 2 was drawn. As one can see, the ureter at this level is surrounded by muscle bundles. The ureter at this level is very near the cervix, and it would take but little involvement of the parametrium, either by direct extension or metastases, for the cancer to reach or extend beyond the ureters.

its spreading into the surrounding tissues and forces it to extend along the ureter.

ORIGIN OF URETERAL SHEATH.

It would seem that the sheath was due to the activity of the ureter; the peristalsis, with its sliding motion and distension and contractions of the ureter, forms out of the surrounding tissue a channel, the walls of which

Fig. 4.—Transverse section of the ureter showing the relation between the fibrous portion of the ureteral sheath and the muscular portion, $\times 2\frac{1}{4}$. Transverse section of a portion of the parametrium from the same specimen from which Figures 2 and 3 were made, and about half way between the two. In the outer wall of the ureter can be seen heavy muscle bundles suggesting that the muscular sheath (Waldeyer) arises from the ureter, as Disse claims; on the other hand, other muscle bundles may be seen alongside of the ureter, which may come from the bladder (?). Outside the ureter and the remnants of the muscle bundles can be seen a fibrous sheath, which blends with the muscular sheath and gives rise to the fibrous sheath in Figure 2.

Fig. 5.—Demonstrating the effect of the invasion of the ureteral sheath by carcinoma cervicis uteri, $\times 2\frac{1}{4}$. Transverse section of the right parametrium and one-half of the cervix from a specimen of hysterectomy for carcinoma cervicis uteri, in which the lower portion of the right ureter was sacrificed and the renal ends of the ureter implanted in the bladder.

may be called a sheath. In support of this view it may be said:

1. The sheath, as such, is absent in the fetus.
2. In a case of double ureter, in which the ureters were close together, one sheath was common to both.
3. Its structure varies with that of the surrounding tissue.
4. The ureter, deprived of its sheath, may form another from the tissue in which it becomes imbedded. A patient was readmitted to this hospital in April of this year with a recurrence of carcinoma cervicis uteri about the left ureter. At the first operation, six months before, the ureters had been freed and the ureteral sheath removed with the uterus and growth. The recurrence, which was about the size of a hen's egg, was removed with the lower 4 cm. of the ureter, and in studying the specimen it was found that a new sheath had formed about the ureter from the tissue in which it had become imbedded.
5. The sheath is developed best in parts where there is opposition to its contractions and expansions, as in the pelvis; while in the abdomen, where the ureter lies in loose adipose and fibrous tissue, which offers very little

Fig. 6.—Demonstrating the relation between a metastasis to a minute parametrial lymph node and the ureter, $\times 2\frac{1}{4}$. Transverse section of left parametrium and portion of the cervix. The double ureter has but one ureteral sheath instead of two, thus suggesting that the sheath is derived from the pelvic structures along or through which the ureter passes and not from the ureter. Four lymph nodes are shown, and the one situated lateral and posterior to the double ureter is carcinomatous.

resistance to the peristalsis of the ureters, the sheath is imperfectly formed or absent.

RELATION OF THE URETERAL SHEATH TO DISEASED CONDITIONS.

One can see how the sheath would protect the ureter from inflammatory processes and new growth. On the other hand, thickening of the sheath from these diseased conditions might interfere with the function of the ureter. An interesting condition arises where a stricture occurs at the vesical end of the ureter. The ureter becomes distended and frequently very tortuous, and sometimes kinked. Normally, one finds certain constrictions in the ureter, one below the kidney and another at the brim of the pelvis, apparently due to a thickening of the surrounding tissue (sheath) at this place. Where a hydroureter occurs, these constrictions become more marked and the ureter markedly distended above and below the constrictions where the tissue about the ureter is loose and the sheath formation less perfect. When a kinking of the ureter takes place it is apparently due to

a rupture of the tissue surrounding the ureter, i. e., a hernia of the imperfect ureteral sheath with a protrusion of the ureter and consequent kinking of the ureter by the hernial ring thus formed.

RELATION BETWEEN CARCINOMA CERVICIS UTERI AND THE PELVIC URETERAL SHEATH.

One realizes that the uterus is a relatively movable organ. On the other hand, the ureters follow the pelvic wall and near the bladder they begin to approach each other, so that the distance between the ureteral orifices is from 2 to 3.5 cm., varying in different cases and with the degree of distension of the bladder. As the ureters are relatively fixed, the relation between them and the uterus is dependent on the position of the uterus in the pelvis, whether in anti- or retroposition, high in the pelvis or in the descensus, and especially in the lateral positions of the uterus, for when the cervix is in the right side of the pelvis it will be much nearer the right than the left ureter, and vice versa. At the level of the internal uterine os the ureters may be 7 to 9 cm. apart and consequently would be some distance from the sides of the uterus; on

Fig. 7.—Demonstrating the relation between a large carcinomatous lymph node and the ureter, $\times 2\frac{1}{4}$. From the same case as the section represented in Figure 6. This carcinomatous lymph node, which had become necrotic and cystic, is situated lateral to the right ureter and is the node sometimes found near the crossing of the uterine artery and ureter.

the other hand, at the level of the external os they are much nearer together and their distance from the cervix may be less than 5 mm., depending on the size of the cervix and its position in the pelvis. It becomes evident that carcinoma cervicis uteri does not have to extend far into the parametrium either by direct extension or metastases, to reach or extend beyond the ureters.

The relation between carcinoma cervicis uteri and the ureters manifests itself clinically, in renal insufficiency resulting from a compression of the ureters by the growth and in the frequency of accidental injury to the ureters occurring during operation for the removal of the growth, there having been in this hospital 19 cases of accidental injury to the ureter in 156 hysterectomies for carcinoma of the cervix, as compared with only 11 similar injuries in 4,513 other major gynecologic operations.

A study of fifteen specimens removed by the more radical operation, i. e., where an attempt is made to remove the lymphatics from the sides of the pelvis and with them the uterus and growth and all the parametrium, either dissecting the ureters free or else resecting the

lower ends of them and implanting the renal end in the bladder, has shown that in twelve cases the growth has extended beyond the uterus, thus clearly demonstrating why hysterectomy so seldom cures this condition. In seven of the twelve cases there was a direct extension of the growth from the cervix. There were metastases to the parametrial lymph nodes in four cases, and metas-

Fig. 8.—Demonstrating the invasion of the ureteral sheath by carcinoma cervicis uteri, with resulting compression of the ureter. $\times 4$. The ureter is surrounded by the growth. The sheath, being derived from the tissue through which the ureter passes, can not be differentiated from it, and the effect of the invasion of the growth into the sheath is to compress the ureter, giving rise to hydronephrosis above.

Fig. 9.—Demonstrating the hydronephrosis caused by the invasion of the ureteral sheath by carcinoma cervicis uteri, $\times 4$. From same specimen as the one shown in Figure 10, demonstrating the hydronephrosis caused by the ureteral sheath which has been invaded by the cancer.

tases have been found in the other pelvic lymph nodes in six out of twelve cases in which they have been studied.

Pathologically, the close relation between carcinoma cervicis uteri and the ureters shows itself:

1. In the distension of the cervix by the growth, thus diminishing the distance between the ureters and the cervix.

2. In the direct extension of the growth from the cer-

vix into the parametrium. As the distance between the ureter and the cervix may be less than 5 mm. in the lower portion of the parametrium, which, unfortunately, may be the part of the parametrium first involved by a direct extension of the growth, it takes but very little involvement of the parametrium to reach or extend beyond the ureters.

3. In the metastases to the parametrium, which may occur:

(a) In the large parametrial lymph node, occasionally found at the place where the uterine artery crosses the ureter.

(b) In the small parametrial lymph nodes scattered throughout the parametrium.

(c) In (intravascular?) lymph nodes which apparently protrude into the lymph channels like sponges and may be present in large numbers in these cases. These may be true intravascular nodes or the apparent lymph channel may be an artefact.

Fig. 10.—Demonstrating the reformation of the ureteral sheath about a ureter which had been freed in a more radical operation for carcinoma cervicis uteri, $\times 4$. The lower 4 cm. of the left ureter was excised with a recurrence of carcinoma cervicis uteri. Primary operation six months before, when both ureters had been freed from their sheaths.

(d) In the other structures of the parametrium, as sheaths of nerves, ganglia, lymph spaces, etc.

Whatever the form of the invasion of the parametrium it does not have to extend far in order to reach the ureter. In Figure 5 is a drawing from a specimen in which the growth has extended out from the cervix and has involved the ureteral sheath and one can see that the latter has become hypertrophied, thus better protecting the ureter; while in Figures 8 and 9, from another case, the growth has surrounded the ureter with its sheath, compressing and invading the sheath, thus giving rise to a hydroureter above. In Figure 6 is a drawing showing a metastasis to one of the minute (intravascular?) parametrial lymph nodes, which is situated lateral to the double ureter. One finds in the parametrium of these cases minute parametrial lymph nodes which may have a diameter of not over 1 to 2 mm. The nodes have the same structure as the larger lymph nodes found throughout the body, and cancer may metastasize to them without causing any increase in their size. In some cases these nodes give the impression of having been made in a

hurry; about them are apparent lymph spaces, and the picture is that of an intravascular lymph node which protrudes into the lumen of the lymph channel like a sponge. These nodes may be the same as the other minute lymph nodes above referred to and the intravascular appearance may be an artefact. The entire subject needs further study.

An invasion of the larger lymph nodes sometimes found in the parametrium is shown in Figure 7. In this instance the node was situated lateral to the ureter and one can see that the portion of the ureteral sheath next to the node is markedly thickened.

ABILITY OF THE URETERAL SHEATH TO RESIST THE INVASION OF CARCINOMA CERVICIS UTERI.

As has been stated, the ureteral sheath is derived from the tissue along or through which the ureter passes, and on this account it is no more able to resist the invasion of carcinoma cervicis uteri than the rest of the tissue

Fig. 11.—Demonstrates the destruction of a new-formed ureteral sheath and the invasion and compression of the ureter by recurrence of carcinoma cervicis uteri, $\times 4$. Same specimen as one shown in Figure 10, but at lower level.

from which it is made, and its apparent ability to resist the invasion of cancer does not depend on any quality inherent in it, but on the nature of the growth. Growths differ greatly in their manner of invading the surrounding parts. One will find a large cancer, which in its growth tends to become encapsulated. The expansion of the growth seems to convert the surrounding tissues into a capsule, and the direct invasion of the surrounding tissue may take place, apparently, very slowly. On the other hand, in another growth there may be no evidence of expansion or encapsulation, but the growth extends in all directions into the surrounding parts, causing but a very little increase in the size of the parts involved. In Figure 5 the invasion of the ureteral sheath has apparently caused a hypertrophy of the sheath which would serve to protect the ureter, but later this very hypertrophy may compress the ureter and cause renal insufficiency. A similar condition is shown in Figure 7, in which the wall of the sheath next to the cancerous lymph node has become greatly hypertrophied, thus apparently protecting the ureter from an invasion of the growth. In Figures 8 and 9, from another case, one can see that the ureteral sheath apparently is affected by the invasion of

the cancerous growth in no way different from the rest of the surrounding tissue.

In another instance in which I had the opportunity of studying the relation between the growth and the ureter, I found that the growth had apparently broken into the ureteral sheath and had extended along the ureter within its sheath, and the latter in places was intact.

REGENERATION OF THE URETERAL SHEATH.

In November, 1903, I removed a cancerous uterus by one of the more radical operations. The pelvic lymphatics were removed with the uterus and growth and the parametrium out beyond the ureters. The latter were shelled out from the sheath, which was incised along its lateral surface. A study of the specimen showed metastases both to the parametrium and pelvic lymph nodes, while the primary growth was apparently entirely removed. The patient returned in April, 1904, complaining of some indefinite pain in the left side of the pelvis. Pelvic examination showed a lump about the size of a hen's egg apparently about the lower end of the left ureter. In April, 1904, an exploratory operation was made and this lump proved to be a return of the cancer, probably from a minute lymph node which had been overlooked and was situated laterally and below the left ureter. The mass, about the size of a hen's egg, was removed with the lower 4 cm. of the ureter and the renal end of the ureter was implanted in the bladder.

An interesting pathologic feature about the case was that a new ureteral sheath had formed from the tissue in which the barred ureter had become imbedded, as shown in Figure 10, and that this latter had become invaded by the cancerous growth, as shown in Figure 11, where one can see that the growth has destroyed the portion of the ureteral sheath next to it and has pushed the ureter against the outer wall of the sheath, and soon the left kidney would be thrown out of function.

CONCLUSIONS.

1. The pelvic portion of the ureter is surrounded by a sheath which is apparently derived from the tissue along or through which the ureter passes and owes its origin to the peristaltic movements of the ureter, thus causing intermittent pressure on its surrounding tissue. In favor of the above it may be said: (a) That the sheath as such is absent in the fetus; (b) that in a case of double ureter, in which the ureters were close together, one sheath was common to both; (c) that its structure varies with that of the surrounding tissue; (d) the ureter deprived of its sheath may form another from the tissue in which it becomes imbedded; (e) the sheath is developed best in parts where there is opposition to its contractions, as in the pelvis; while in the abdomen, where it lies in loose adipose and fibrous tissue which offers very little resistance to the contractions of the ureter, a definite sheath is imperfectly formed or absent.

2. Near the bladder the ureter is reinforced by muscle bundles, some of which apparently come from the bladder, as described by Waldyer, while others are apparently derived from the outer coat of the ureter, as described by Disse. These muscle bundles also form a sheath about the ureter, with which the sheath previously referred to fuses. While the two may be considered different portions of one sheath, on account of their origin and the fact that the lower end of the fibrous sheath apparently encircles the upper end of the other, they should be considered as separate structures.

3. The formation of a sheath about the abdominal portion of the ureter is very imperfect and in places apparently absent, which may possibly be explained on the ground that the surrounding tissue is loose and on

this account offers little resistance to the contractions and expansions of the ureter.

4. The inside of the sheath is filled with adipose tissue and fine strands of connective tissue in which are imbedded the larger vessels of the periureteral vascular plexuses, and also possibly lymph channels.

5. While this sheath protects the ureter from the invasion of inflammatory processes and new growths, at the same time the local thickening of the sheath may interfere with the function of the ureter, thus giving rise to hydronephrosis and renal insufficiency and predisposing the kidney to infection, and in cases of ureteritis helps form the thickened ureter found in these cases.

6. Stricture of the lower end of the ureter demonstrates the imperfect formation of this sheath, as where the sheath is well formed expansion of the ureter is restricted, causing a stricture, while above this place the loose tissue (sheath) about the ureter may give way, permitting the tortuous condition and kinking of the ureter sometimes found in these cases, i. e., a hernia of the ureter through its sheath.

7. The ability of the ureteral sheath to resist the invasion of carcinoma depends more on the nature of the particular growth than any quality of the sheath, for the latter is derived from the surrounding tissue and behaves toward the growth as does the rest of the tissue about it. (a) In some cases one finds a marked hypertrophy of the sheath, thus temporarily protecting the ureter, and later this hypertrophy may compress the ureter. (b) In other cases the ureteral sheath may be invaded with very little or no apparent attempt at hypertrophy, while in one case studied the growth gained access to the inside of the sheath and extended along the ureter within the sheath.

8. This sheath is of importance in operations in the pelvis, for if the integrity of the sheath is preserved, that of the ureter is assured. On the other hand, freeing the ureter from the sheath, unless done with great care, is attended with dangers of ureteral necrosis. Also in ureterovesical implantations the ureteral sheath should be preserved and sutured to the bladder, thus not only protecting the ureter, but, what is also of great importance, the tension of the implantation is relieved.

EXCISION OF PART OF THE ILEUM AND ALL OF THE CECUM AND ASCENDING COLON.

ILEUM AND TRANSVERSE COLON UNITED BY A NEW METHOD.*

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The various ingenious methods used at present to unite the divided ends of the intestinal tract are prima facie evidence that no one method is satisfactory in all cases. The trend of surgical opinion seems in the direction of suture, as against mechanical appliances, and this results from the fact that an operative procedure requiring for its performance special apparatus is thereby handicapped. When the appliance is one that must be left in the intestinal canal till healing has been completed, additional disadvantages, such as gangrene and obstruction, at once suggest themselves. Undoubtedly, mechanical contrivances are sometimes indicated, but

* Read at the Fifty-fifth Annual Session of the American Medical Association, in the Section on Surgery and Anatomy, and approved for publication by the Executive Committee: Drs. DeForest Willard, Charles A. Powers and J. E. Moore.