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Surgical Measures in Hypertensive Patients*

By R. H. SMITHWICK, M.D.

BOSTON, MASSACHUSETTS

IT must be clear to everyone that hypertension is a somewhat complicated subject and one that is by no means completely understood. There are many theories and I will not take time to go into these in detail.

FACTORS RELATED TO THE ETIOLOGY OF HYPERTENSION

To discuss the matter in the simplest fashion, it would seem that there are three factors concerned with the development of continued hypertension in man. First of all, and not necessarily the most important in every case but perhaps the most important in some cases, is the nervous factor. Second, there are humoral factors, and third, there is the factor of vascular disease. All these three factors combine in an amazing variety in patients with continually elevated blood pressure so that we place them in more or less of a "hodge-podge" and cover the disease with the name "essential hypertension". Eventually, no doubt, ways and means will be devised for dividing these patients into various categories. I think we should not have the feeling that everybody with essential hypertension has exactly the same disease. I am perfectly certain that is not so, but the unfortunate thing is that we do not know how to classify them with accuracy as yet.

What I would like to do is to speak about what can be expected following extensive sympathectomy as a form of treatment of this disease. You are all aware of the fact that hypertension is responsible for more deaths per year than any other disease of man, and consequently is deserving of a great deal of thought, and is receiving it from workers in all fields of endeavour. The only other surgical measures that are of any value whatsoever and unfortunately applicable only to a very occasional case, is unilateral nephrectomy, and that fascinating,

*An abridgement of an address delivered during the course of the seventh Semi-Annual Lectureship, University of Western Ontario Medical School, April 7-9, 1948.

important, but also rare group of cases in which the hypertension is clearly due to a pheochromocytoma. At the moment, I would like to comment on experiences, particularly my own experience, during the last fifteen years, with surgical treatment of hypertension by means of extensive sympathectomy.

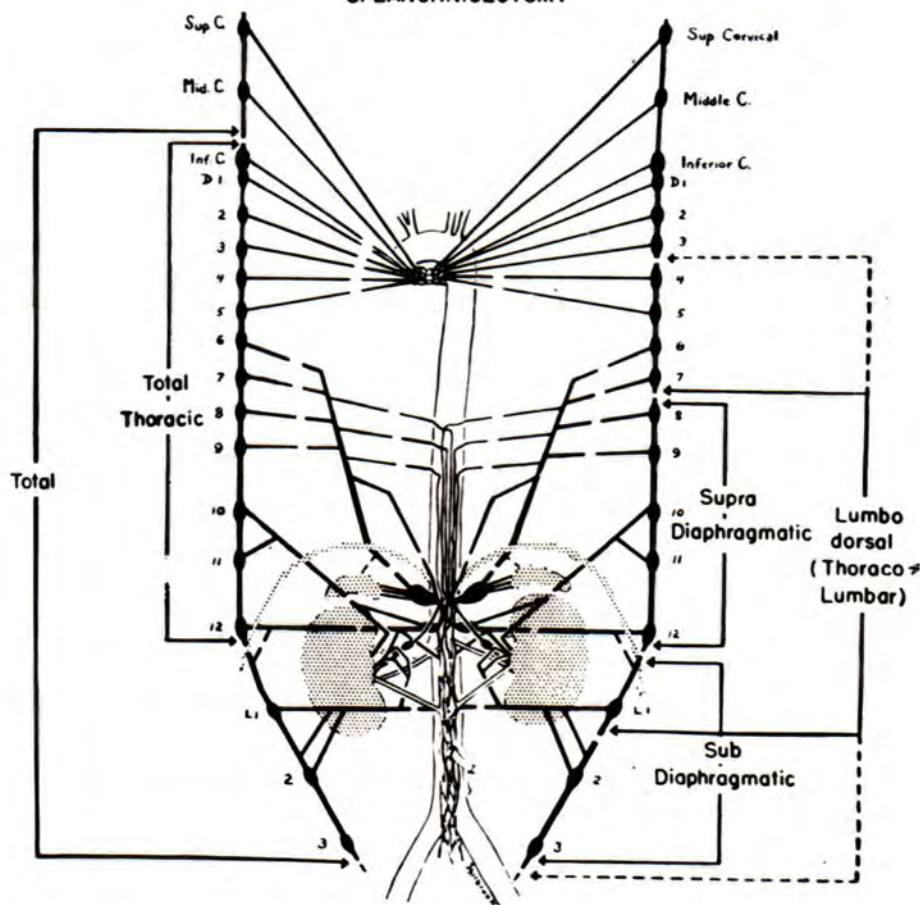
Let us consider the important information regarding the sympathetic division of the autonomic nervous system. It was our hope that in this disease the spasm of the small blood vessels of the body, the large percentage of which are concentrated in the extremities, was implicated as an active mechanism in increasing the peripheral resistance to the blood flow, which is another way of stating the cause of hypertension. As far as anybody knows, there is no change in the blood volume, in the blood density, or the cardiac output. Therefore, most people agree that there must be an increased resistance and it is well known that the major point at which the peripheral resistance is increased is in the arterioles. It is the theory that by disconnecting the arterioles from the central nervous system, a large vascular area would have a lower peripheral resistance through which blood could flow with less pressure, and that the reactions of the blood vessels which result in the unusual irreversibility of blood pressure would likewise be modified and perhaps attenuated. Therefore, as a result of a combination of these two factors, the subsequent strain upon the peripheral vascular bed would be decreased, the progress of the disease would be slight, and life expectancy might be increased.

There are two other possible mechanisms that may be of importance in these operations, one of which is the denervation of the adrenal gland. In all probability, this would abolish reflex secretion of adrenalin which would aid in preventing extensive pressure increases and peripheral resistance in certain vascular areas, which might be of some consequence. The final possibility of sympathectomy is the modification of blood flow through the viscera, as for instance the kidney, such that the blood flow through these viscera would be increased. Renal ischemia would be abolished, which is to say that pressor substances would not be produced by stimuli which previously would cause intermittent periods of ischaemia. By sympathectomies, the blood flow would probably be stimulated to a higher level but not higher than the maximum flow prior to the operation. It is felt that sympathectomy brings about release of spasm that takes place in the viscera just as it does in the extremities, although that has not been properly demonstrated as yet. I would like to try to tell you how far our studies have led us in reaching conclusions with regard to these various points.

SURGICAL PROCEDURES

The accompanying diagram represents a summary of the various techniques which have been utilized to denervate the vascular bed.

SURGICAL TREATMENT OF HYPERTENSION

DIAGRAMMATIC REPRESENTATION OF VARIOUS TYPES OF SYMPATHECTOMY AND
SPLANCHNICECTOMY

The sub-diaphragmatic technique, which consists in removing the sympathetic chain just below the diaphragm, is probably the least extensive of all of the various manoeuvres. I would judge from the literature and my own experience that it results in a somewhat lesser degree of success in modifying the hypertensive state than the other manoeuvres. In addition to being less extensive, it has one other difficulty, namely, that the amount of the chain that can be resected by an exposure which is entirely beneath the diaphragm is very small. Only short segments can be removed and what is left will regenerate with great rapidity. It is this difficulty of removing large segments that favours regeneration. Great splanchnic paths are missed, as are other vasoconstrictor fibres which come off in the splanchnic nerves and run down along the aorta as shown in this diagram.

Then, there is the supra-diaphragmatic technique, in which the sympathectomy is carried out from the eighth to the twelfth cervical levels; the lesser and greater splanchnic nerves are removed over an extensive area, thus interrupting stimuli to the coeliac plexus. This is a more extensive procedure and is more effective and safeguards against regeneration to a much greater degree than the sub-diaphragmatic technique. However, the difficulty with this procedure is that it does not permit examination of the adrenal gland. It is only by extensive examination of the adrenal gland that we have found a large number of adrenal tumours in patients, the presence of which was entirely unsuspected. Another difficulty is that lumbar fibres in some patients may carry vasoconstrictor fibres to the viscera, which apparently are of considerable consequence. It seems wiser to divide the diaphragm and to remove a portion of the sub-diaphragmatic outflow, as well as the supra-diaphragmatic outflow.

The thoraco-lumbar (lumbo-dorsal) manoeuvre is simply a combination of the two previous procedures. Here, the minimal procedure consists of the bilateral removal of the ganglia from the eighth cervical to the first lumbar, inclusive, and a maximal procedure includes the higher thoracic levels. All of the splanchnics are excised as shown by broken lines in the diagram, and the adrenal is examined for the existence of a tumour.

There are two other techniques, namely, total thoracic sympathectomy and thoracic sympathectomy. In other words, every conceivable procedure has been tried. With regard to these last two procedures, my experience with either of them has not been great but I have, over the years, come to recognize that there may be a place for total thoracic sympathectomy. We have reserved this for certain patients who do not seem to do well after thoraco-lumbar sympathectomy because of cardiac difficulties. There are certain patients, particularly those with coronary heart disease and angina pectoris, who are suitable candidates for surgery but who, following the thoraco-lumbar manoeuvres, continue to have angina pectoris, and are disabled. In these patients, we have found it preferable to denervate the heart and to do a total thoracic and thoraco-lumbar manoeuvre. There is a second group of patients who have unusual tachycardia—an unfavourable sign so far as the bulk of hypertensive patients is concerned. It is not only unfavourable but patients who have unusual tachycardia before operation will have even greater tachycardia afterward, and this may result in considerable disability. We have learned this by experience and have had to denervate the heart in certain patients following thoraco-lumbar manoeuvres because of a persistent and disabling tachycardia. So when we see a hypertensive patient with an unusually rapid heart rate and an unusually rapid increase on testing in the upright position, we do a sub-total thoracic denervation rather than a thoraco-lumbar procedure.

In order to control the heart rate, it is not necessary to go above the second thoracic ganglia. We find that good results are obtained with bilateral sympathectomy from the second to the twelfth thoracic ganglia in that particular group of patients. These two groups of patients (angina and tachycardia) represent perhaps twenty per cent. of the patients seen today.

Total sympathectomy is a very extensive manoeuvre. It has been carried out in certain individuals. I have done about twelve or fifteen in all, never as a primary manoeuvre but always after failure of success following lesser manoeuvres. It is my feeling that it is an extensive procedure to do in patients with hypertension. The after-effects detract from the good you can do with this form of treatment. A considerable percentage of patients thus treated are incapacitated; homeostasis fails, with a consequent prolonged disability. They have been able to get around, though they cannot stay upright without fainting. I have three patients now who, after two or three years, are still totally incapacitated. They will eventually adjust themselves, I am sure, but the period of disability that goes with it makes it an impractical procedure, in my opinion. However, there are others who disagree with me. They have never had any such trouble, but I have on two or three patients, which is just about as many as I want to have. It is my considered opinion that this form of treatment has a certain amount of value in only a few hypertensive patients. You greatly increase the disability and you can do a milder form of sympathectomy with better success. I think that for the vast majority of people, a reasonable manoeuvre is the thoraco-lumbar, as outlined above, which includes exploring the adrenals carefully and looking at the kidneys. That is just about what the patients can stand. They get back to work in a reasonable time and do not have too much disability. After a good many years of trial and error we have come to this conclusion.

The reason we have extended the operation beyond the method which we used originally was because we re-operated on a number of our failures and were able to convert a certain percentage of them into comparative successes by extending the procedure. In other words, we convinced ourselves by multiple stage operations, in the same patient, that failure to modify the hypertensive state was the result of anatomical variations which could not be adequately predicted beforehand. For example, consider one of the patients that we operated on, over ten years ago. He first had a period of observation with blood pressure readings of 240/140 mm. Hg. During the period of observation the patient had a stroke from which he recovered satisfactorily with little or no residual damage. The blood pressure at that time fell slightly (230/130 mm. Hg.) but it was still too high. A bilateral supra-diaphragmatic splanchnicectomy was then performed and the blood pressure fell a little more (210/120 mm. Hg.). Five months later, he

had a bilateral lumbar sympathectomy. His pressure fell to a level of 160/100 mm. Hg. and was there for a period of study (three years).

HOW TO STUDY A PATIENT PREOPERATIVELY

After a period of at least two days' bed rest, the patient is studied by trained technicians rather than by physicians. Technicians can demonstrate abnormalities of reflex responses which the physician cannot. For some reason or other, the presence of the physician makes the blood pressure go up and you cannot start to study patients unless you have the blood pressure at the basal level. The patient should be settled, preferably in a sound-proof room with a quiet, comfortable environment, and then obtain the following data.

Blood pressure readings are taken every minute for five minutes, with the patient sitting and standing. The patient then lies down for five minutes, with one hand in ice water. Readings are taken at thirty seconds and sixty seconds, followed by five minutes more in the horizontal position. One hand is placed in ice water again, and then five further readings are taken. This is "the cold-pressor test" and enables one to get an idea of the blood pressure and the amount of re-activity and reversibility of the blood pressure. Ambulatory readings are, in my opinion, of no value whatsoever. The data must be obtained in the resting condition.

We have been interested primarily from a physiological viewpoint in the effect of operative procedures on the blood pressure levels, but, as pointed out, there are probably other factors that may be of importance, namely, the reversibility of blood pressure. There is a method of study which has been devised recently to help decide whether the vascular bed has been thoroughly denervated or not, and whether or not elevations in blood pressure are abolished. This has nothing to do with changes in blood pressure levels as elevated by various stimuli. This test is the Valsalva test in a modified form. A continuous recording of the blood pressure is necessary from a trachial artery cannula, with the pressure recorded optically by means of a Hamilton sphygmomanometer; then the patient exhales against forty mm. Hg. pressure for ten seconds. The stimulus is then removed, with the result that widespread vasoconstriction occurs and the blood pressure rises sharply and then falls again gradually. The whole record is of fifty seconds duration. You cannot get these changes with an ordinary sphygmomanometer. The blood pressure falls as the patient breathes against pressure. Then when the stimulus ceases, the blood flow to the heart increases, widespread vasoconstriction occurs, and there may be a terrific blood pressure occurring within fifteen seconds, and then it gradually falls off. After the vascular bed is extensively denervated, whether the levels are any lower or not, this reflex response is abolished. The blood pressure falls as the test is performed, but when stimulus

ceases the blood pressure rises slightly to its previous base line over a period of one-half minute or more and does not overshoot. The denervated vascular bed acts as a shock absorber. The effect of denervation in preventing this reflex may be of importance, in addition to any change in the blood pressure level.

There is a point beyond which the benefit of lowered pressure fails to make up for the continued disability. It is my feeling that one should be on the conservative side so far as the extent of the operation is concerned. Aside from the extent of the operation, and the many other factors of great importance in relation to the results, the most important thing is the selection of patients for surgery. I think that is almost more important than the extent of the operation, although probably there is a close tie-up between the two. With regard to selection of patients for surgery, one may think it a simple matter but it is a very complicated one because, as I have implied, these patients do not all have exactly the same disorder. They all have elevated pressure but the various factors that are playing a part in producing the high blood pressure are not constant. I find it very difficult to categorize hypertensive patients.

SELECTION OF CASES FOR SURGERY

Basis for Subdivision

	No. Groups
1. Sex	2
2. Age of patient, (a) below 40, (b) 40 and over.....	2
3. Type of Hypertension.....	3
	—
Total	12

First is the question of age. We see these patients from five to sixty years of age. You cannot put a five-, ten-, or twenty-year-old subject in a group with patients who are forty, fifty, or sixty years of age. The younger the patient, the better the outlook for improvement following operation. We would like to be able to put these people into decades as regards age, but that would mean at least four or five variables. For convenience, we often consider two categories—those patients who are over forty and those under forty.

Second is the question of sex. You cannot discuss hypertension in the male in the same breath with hypertension in the female. The course of the disease is entirely different in the two sexes. For some reason or other, females tolerate the disease better than males. The outlook for the male patient, as far as life expectancy is concerned, is much poorer and the mortality is twice as great as that for females. Therefore, we have to divide them according to the two sexes; two more variables.

Further groups of hypertension are obtained when we consider the width of the pulse pressure in relation to the resting diastolic level. For example, a diastolic level of 130; pulse pressure 30 mm. or 40 mm. Here the pulse pressure is less than half the diastolic pressure, a narrow pulse pressure or Type I hypertension. Then there is the intermediate type, where the pulse pressure is equal to, or less than 19 mm. more than one-half the diastolic pressure. This is called Type II hypertension. Finally there is Type III hypertension, where the pulse pressure is 20 mm. greater than one-half the diastolic pressure. Are each of these three types entirely different situations? Does it mean a greater degree of obliteration of the larger blood vessels, which then makes it necessary for the systolic pressure to rise with the heart's contractions to a greater degree? Or is it an index of decreased elasticity of the vascular bed? We do not know for certain, but the pulse pressure is important as far as the results are concerned. The most favourable is Type I, the least favourable being Type III. The older the patient, the wider the pulse pressure normally. So, in general, you can say: the younger the patient the better, the narrower the pulse pressure the better, and females do better than males.

A patient comes to you and is found to be hypertensive, you know he has raised blood pressure but you cannot tell anything by ambulatory readings, because these all are alike. However, if you get him rested, you can start to put him in the proper category. Right off you can say that if you see a young patient, female, who has Type I hypertension, particularly if she has a good response to sedation and not too serious cardiovascular damage, she will do well. With an older male, with a good deal of vascular disease, you can be dubious about what the outcome will be.

Then the state of the brain, heart, kidneys, response to sedation, and the status of the cardiovascular system as a whole has to be taken into consideration. None of the patients know how long they have had hypertensive trouble. The larger the heart, the worse the outlook, because this implies long-standing hypertension—greater evidence of cardiovascular disease. Thus, to put patients into categories, you have to know all these factors. You have to have a tremendous number of cases of different age, sex, severity of raised diastolic pressure, response to sedation, status of cardiovascular position, in order to get cases in the same group.

CONTRAINDICATIONS

These are: (1) Nitrogen retention; (2) actual or impending cardiac failure; (3) if renal function is impaired; (4) if the changes in the cardiac area are marked; (5) resting diastolic pressure of 140 mm. or more.

In deciding the degree of renal functional impairment, we find most helpful, not the ordinary concentration test, which is generally emphasized as being very important, but the intravenous P.S.P. (phenolsulfonephthalein) test. This tests the actual renal blood flow. The test is preceded by the adequate forcing of fluids. In the first fifteen minutes fifteen per cent. of the dye should be recovered. This is the important part of the test. The total output should be sixty per cent. or more in two hours. Fifty per cent. in two hours is the critical level.

We find it very difficult to compare our results with those of others, since most have reported on ambulatory readings. The Mayo Clinic, however, divide their cases on the basis of eyeground changes, the details of which I will not bother with now, so we can compare our series with theirs on this basis.

MORTALITY IN UNSELECTED HYPERTENSIVE PATIENTS, CLASSIFIED
ACCORDING TO EYEGROUNDS AND FOLLOWED 5-9 YEARS

Grade Eyegrounds	<i>Keith, Wagener and Barker (1939)</i>		<i>Smithwick (1948)</i>	
	No. Cases	Deaths	No. Cases	Deaths
Normal	0	0 (0%)	10	1 (10%)
1	10	4 (40%)	57	9 (16%)
2	26	17 (65%)	56	11 (20%)
3	37	34 (92%)	54	27 (50%)
4	146	145 (99%)	35	19 (54%)
Total	219	200 (91%)	212	67 (32%)

To summarize, these are the patients that we have followed to date: 212 cases operated upon, 1938-1942 inclusive, a period of nearly five years. We have recently checked these patients as of January 1st, 1948; 212 cases—unselected and with continued hypertension and practically all suffering from cardiovascular damage; thirty-two per cent. of the patients were dead. When we compare the life expectancy according to eyeground groups of Keith, Wagener and Barker, ninety-one per cent. of whom were dead in five to nine years, life expectancy seems to be materially improved. With regard to other data, it is outlined in the following table:

SUMMARY OF LATE RESULTS (5-9 YEARS) OF LUMBODORSAL
SPLANCHNICETOMY IN UNSELECTED HYPERTENSIVE PATIENTS

(a) *Life Expectancy*—212 Cases

1. Total mortality, 32%.
2. Life expectancy appears to be increased, particularly when compared with the statistics of Keith, Wagener, and Barker.

(b) Follow-up Data—100 Patients

1. Cardiovascular system improved, 43%; no progress, 29%; worse, 28%.
2. Lowering of blood pressure: marked, 21%; moderate, 13%; slight, 13%; minimal, 19%. Blood pressure unchanged or higher, 34%.
3. Symptoms: improved, 92%; unchanged, 5%; more severe, 3%.

If it is possible to compare statistics in any two different series of cases, it would seem as though the progress of the disease had been slow and that something worthwhile had been accomplished so far as life expectancy is concerned. One other point that I would like to bring out is to compare the grade of blood pressure response by years—one to five years with that five to nine years after operation—according to the grades that I have shown you.

COMPARISON OF BLOOD PRESSURE RESPONSE 1-5 YEARS AND 5-9 YEARS
AFTER LUMBODORSAL SPLANCHNICOTOMY IN 100 CASES

Grade B.P. Response	No. Cases 1-5 Years	No. Cases 5-9 Years
1. Marked	35	21
2. Moderate	29	13
3. Slight	20	13
4. Minimal	0	19
5. No change or higher	16	34

Then there is this very interesting table, a comparison of the relation of reduction of blood pressure and progress of cardiovascular disease:

RELATION BETWEEN REDUCTION OF BLOOD PRESSURE AND PROGRESS OF
CARDIOVASCULAR DISEASE—100 CASES FOLLOWED, 5-9 YEARS

Grade B.P. Response	No. Cases	Progress of Cardiovascular Disease
1. Marked	21	0%
2. Moderate	13	7.5%
3. Slight	13	15.0%
4. Minimal	19	26.3%
5. No change or higher	34	58.8%

In other words, it would seem as though the lowering of the blood pressure as the result of operation had definitely protected the cardiovascular system and that the greater the lowering of pressure, the greater the protection that the patient derived. It is in keeping with the concept that hypertension itself is not a harmless matter but that it has to do

with the progress of cardiovascular damage, and that if the hypertension can be rendered less severe by one method or another (I do not know whether all methods are equally effective in this regard), I think one is justified in concluding that the lowering of blood pressure is desirable rather than undesirable. In the early stages, people predicted that hypertension was essential in order to nourish the tissues, in order to force blood through the tissues, but apparently that is not so.

The same holds as regards the status of electrocardiography. We have been interested in trying to find out the evaluation of electrocardiograms in non-surgically treated hypertensive patients. In the literature, eighty-nine cases have electrocardiograms recorded over a period of five years or more, the percentage showing a favourable change of nine per cent. With surgical treatment, forty-four per cent. showed improved electrocardiograms.

STATUS OF ELECTROCARDIOGRAMS OF HYPERTENSIVE PATIENTS
FOLLOWED FIVE YEARS OR MORE

Treatment	No. Cases	Improved	No Change	Worse
Non-Surgical*	89	9%	47%	44%
Surgical†	100	44%	49%	8%

Generally speaking, the lowering of the blood pressure protects the cardiovascular system and slows the progress of heart disease as indicated by electrocardiographic changes. I wish to leave you with the impression that in some of these patients, although the result at the end of five to nine years is worthwhile, it is not as good as it was a year or two after operation.

In general, one can say in dealing with selected patients with continued hypertension and cardiovascular disease, that we have observed marked improvement following denervation of the vascular bed. In unselected cases, results of all sorts have been observed following surgical treatment. Surgical intervention on the autonomic nervous system appears to be an important factor in the hypertensive state. The course of the disease can be modified to the relief of the cardiovascular disease and life expectancy can be improved. However, the great problem still is to select the patients, study them carefully, and place them into categories. Such categorization as early in the disease as possible should result in a very high percentage of good results with a maximum salvage of life insofar as we can predict today.

*Total of White, P.D., et al, 1945, and Rasmussen and Boe, 1945.

†Smithwick, 1948, unpublished data.

“Science and Canadian Welfare”*

By DAVID L. THOMSON, PH.D., F.R.S.C.

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and Research, McGill University*

OFTEN and affectionately we personify the University to which we owe allegiance; we call her Alma Mater; we speak of her sons and daughters. We recognize that she has her individuality, her own memories and mannerisms, which in a score of subtle ways set her off from all others. Superficially, in the recurring ceremonies of the academic session, she appears to be bound more rigidly than any of us to the solar year; but, looking more deeply, we perceive that the significant events of her history conform to no annual calendar. She has had her Summers of lassitude, her Springs of rejuvenation, but the rhythm of these seasons is mysterious and slow; nor can any man predict the intervals at which she will next feel stealing upon her the retrospective mood of a birthday, or the need of courageous resolutions with which to enter a new year. Here and now, however, beyond doubt, we recognize and celebrate one of these turning-points in the story of this young and vigorous University; and it is “altogether fitting and proper” that we should mark it by raising our eyes for a moment from the path immediately before us, and trying to peer myopically at the landscape that lies around us and ahead.

This landscape! We see it mottled and obscured by the shadows of the scudding clouds of war, before which we individually feel as helpless as the lonely wayfarer before the thunderstorm. We see that the country has been optimistically mapped in the name of democracy and political equality for all, whereas active participation has become the prerogative of the thick-skinned few, and millions of us feel constrained by our employers or our associates to breathe our true opinions at best only in the confessional of the ballet-box. We find ourselves ringed-in by concentric circles of contradiction; the interest of our selves and our families conflicts with the interest of our institution or company, which may not be in harmony with the interest of our country, which may run counter to the total interest of humanity as a whole. All this and much more, encouraging or dispiriting, we see at the first glance. Yet in the whole complex scene there is but one feature to which I am licensed to direct your attention this afternoon: that is, that we see on every hand, and especially ahead, the material and immaterial structures raised by that aspect of the human intellect which we call Science. Beckoning or menacing, there they are all around us;

*Address given at the inauguration of Dr. Hall as president of the University of Western Ontario, March 8, 1948.

for we live in an age and in a country which have chosen to stress that aspect of the mind; what does it mean, to us and to our successors?

I do not propose to recite here the story of what science has already done for Canada's material welfare. You are all familiar with our development of new strains of crop-plants, that have allowed us to push the frontier of cultivation further and further into the North, and with the part that science has played in developing our mineral resources, our utilization of the forests, and our ability to help our allies both in war and in reconstruction. Still less do I propose to venture prophecies of the new discoveries and new inventions that are certain to remould the economic structure of our country. This structure, let us take it for granted, is now and will be increasingly founded upon scientific knowledge; but our country is, let us hope, something more than an economic unit. I remember that during the war an angry manufacturer wrote that the Canadian way of life was being threatened because the Government would not allot him the tin he needed to market his product, diced mixed vegetables. But surely we have a pattern of life here that cannot be wholly expressed in terms of diced vegetables and refrigerators and the hope of television! Surely Canada has a mind and a soul, not merely a gadget-greedy belly; and it seems to me important to enquire how that mind and soul are likely to be influenced by our irrevocable and increasing acceptance of science as part of our scheme of life.

The answer must depend very largely on the spirit in which we approach our science. Do we think of science primarily as a well-tilled field, ugly and uninteresting save when it produces a crop of inventions for our material comfort; or is it first of all an attempt to reduce to comprehensible order the complex and bewildering universe in which we find ourselves? This brings up at once the old cleavage between "applied" and "fundamental" research, and the problem of striking a nice balance between them. It is hard to find anything fresh to say about this; but I believe that Sir Edward Appleton has made a real contribution to clear thinking by his recent suggestion that we should think not of two categories of science, but of three. At one end of the scale stands research conducted with no thought at all of practical applications; which is not to say that applications may not later be found. From innumerable examples, I might select the study of microscopic fossil Foraminifera in limestone: at first sight an enquiry of the most useless and introverted sort, this study has come to furnish valuable clues in the search for petroleum and now includes, I believe, some of the most jealously-guarded of all trade secrets. At the other end of the scale, science stands upon the frontier of the productive arts of engineering and agriculture and clinical medicine, ready to answer questions that begin, not with "What" or "Why", but with "How"; how shall we achieve our desired and well-defined objective—of making

the administration of penicillin less wasteful, of freeing radio from static, of protecting spruce against the bud-worm? Between these two extremes, as Appleton points out, there is a middle ground, where we have an objective in view, but recognize that the first step is to collect factual knowledge, not all of which will ultimately prove useful. Do we wish to stabilize the smelt fishery of New Brunswick? Let us begin by determining the life-history of the smelt. Do we wish to find a use for the sulphite waste-liquor of our paper-mills? Let us begin by unravelling the chemical structure of lignin. The point needs only to be made to be appreciated; a very large fraction of all our investigations, both in Universities and under Government auspices, lies in this middle territory.

Since this paper refers especially to Canadian welfare, we might, however, classify our research activities in a somewhat different way. To what extent are our findings valuable to Canada specifically, and to what extent are they for the benefit of the whole world? The obvious example of the second type is to be found in medical research. Among the scientists of Canada, past and present, there is no group more outstanding than the group that has worked in the sciences basic to medicine; I do not think that it is merely because of my own special interests that I reach this conclusion; and surely the point needs no underlining before a University that has recently chosen both its President and its Dean of Medicine from this particular group. But let us be impersonal and sceptical for the moment; let us ask ourselves just how much poorer Canada would have been without them. It could be argued, and without the least denigration, that the discoveries of which we are rightly proud would certainly have been made a few years later in some other country; and that physicians and surgeons would have been quick to apply them in practice here, wherever they had originated. Extending this argument, it might be urged that a small country might not be ill-advised to leave medical research, except on local problems, to its larger and wealthier neighbours. To this defeatist attitude there are several rejoinders. Firstly, that even a few months priority in discovery may save hundreds of lives, here and elsewhere. Secondly, that the torch of the investigational spirit warms and illumines the entire national tradition of medical education and medical practice. Thirdly, that among nations, as among players on a team, prestige depends largely on willingness to do a little more than one's share, towards the common goal. Our sceptical question is answered, and answered fully; yet these answers, satisfactory though they are, leave something unsaid. They are inadequate as an explanation of the motives of our greatest scientists: for the restless impulse to question and to study, the drive that carries a man through the toil and disappointments of a great investigation, these are like the inspiration of the poet or the artist in that they are not based on cold calculation and deliberate

choice; they are rather a species of fever of the mind, rare enough in its incidence, racking yet rewarding to those it grips, and sharply reminding the rest of us of the dull normality of our own temperatures.

Yet I think that the world is too passive in its acceptance of advances in medicine. The common attitude to some new life-saving discovery is too much that of a preoccupied child below the Christmas tree, discovering an unopened parcel with, indeed, some pleasure, but no real turning of attention from the toys already spread across the floor. There is little social or economic awareness of the lengthening expectation of life and the changing age-distribution of the population; yet, if we can cold-bloodedly forget all the individual tragedies of illness and death, we can see that every advance in medicine must make it, at least relatively, more difficult for young men and women to win a place in the world against the competition of their surviving seniors. This will become still more apparent when we have a practical outcome from the current concentration of effort on the disorders of later middle-age, such as cardiovascular disease and cancer. Do not misunderstand me; I am far from suggesting that we should relax our efforts in medicine; I *am* urging that we need parallel advances in social and economic thought to keep our human world in balance.

Allow me now to return to the more general problem: what shall we say of a nation in which science and technology represent a very large fraction of the total of higher education? Is such a nation self-condemned to a purely materialistic outlook? One often hears mutterings among the humanities to the effect that the function of science is to describe and classify everything, good or bad, that comes within the sweep of its net; and *therefore* that a training in science can give its votaries no practice in distinguishing good from bad, no experience in making judgments as to values. I believe this view to be entirely fallacious, and I would quote one who is no scientist, Howard Mumford Jones (*Education and World Tragedy*, 1946): "The notion that a scientist is professionally incapable of value judgments is one of the quaintest and most ignorant assumptions that co-called humanists can make."

I do not think that anyone who has ever worked in a laboratory could maintain that the scientist does not have to make judgments as to value. Did he not decide to be a scientist rather than something else? Did he not decide to be, perhaps, an organic rather than a physical chemist? Do you suppose that he chose the substance he is studying by *sortes Beilsteinianae*, rather than because it has some actual or potential human interest? Does he not have to decide, every week, what the next experiment shall be? Every day brings its dozens of minor decisions.

There are, of course, certain over-riding rules. One is that the truth shall be told, however unpalatable it may be. But surely this is true of all scholarship, not merely of science! When Louis Pasteur died, his place in the Académie Française was given to a great mediaevalist, Gaston Paris, from whose inaugural speech I take this ringing challenge: "I believe, absolutely and without reservations, that truth is the objective of science, and that truth must be reached regardless of consequences, be they good or evil, fortunate or unhappy." I am afraid that some of those who maintain that there are no values for the scientist mean no more than that the scientist cannot be trusted to suppress disagreeable truths. It is true, of course, that some scientific discoveries may be spectacularly dangerous if misapplied; are there, then, no ideas in economics or religion over which blood has been shed?

To insist that the scientist has ample opportunity for making judgments of relative value is not to imply that his judgments are always correct. He has his full share of human fallibility; who has not? It is well also to recognize that there are types of error into which his training makes him peculiarly apt to fall. Science deals largely with measurement; and the scientist is no doubt prone to be professionally contemptuous of imponderables. On what thermometer shall we measure degrees of happiness? Yet we all hope for it. Even health is hard to define except by exclusion, while wealth is all too easily enumerated. Again, science has a legitimate trick of simplifying its problems; in theory, for example, we begin our elementary study of falling bodies with the words "neglecting the friction of the air"; in experiment, we reduce variability by controlling temperature or pH, or by using pure-bred strains of plants or animals. This is essential to progress, and it is very well as long as we remember that the factors which we arbitrarily excluded have not really been disposed of. As long as the theory is developing satisfactorily, as long as one experiment leads to another, it is difficult to remember that the foundations still need underpinning; the mere fact that our results are coherent and interesting tempts us to assume that they are of universal application, and that we have neglected only what is truly negligible. The dangers and the penalties of this kind of *petitio principii* are greatest when we apply the scientific method to economic, political, or personal problems.

There is another kind of simplification which the scientist is forced to employ. It is his task to make some part of the enormous complexity of the universe comprehensible to the human mind. He makes a hundred or a thousand observations, and compresses them into a final statement, such as an average or a probability. Remembering the variability of the original measurements, he himself is unlikely to forget that this final statement is a mere statistic; but those who come after him, reading in haste, anxious to apply his findings to some new problem, are only

too apt to suppose that there is something desirable and sacrosanct about that final average, and that deviation from it is "abnormal" in a pejorative as well as in a statistical sense. The biologist knows that in variation lies the hope of evolutionary progress; but the planner finds it inconvenient. He would gladly chop or stretch us all to fit his bed of Procrustes; we should all eat 2,700 calories, buy two suits a year, and have children of exactly the sizes, ages and complexions approved by the advertisements in "Good Housekeeping"; it would make us easier to manage—as easy as the Brachiopod *Lingula*, which has bred almost true to type ever since the Palaeozoic era. From here it is only a step to totalitarian ideology; for true democracy has always stood for the sanctity of the individual and the right of dissent.

We have here, then, a form of error into which misuse or misunderstanding of scientific method may easily lead us; and realizing this helps us to appreciate the value of other elements in our culture. The moralist knows that an action is right or wrong, regardless of the percentage of the population that commits it. The artist and the poet show us the world, not by averages and composites, but by allowing the light of their genius to play upon their selected exemplar, till it glows before us more brightly than the scenes and events of our own immediate experience. The dramatist enunciates his triumphant paradox that "the minority is always right!" The more pity, then, that a careless scientist will at times allow himself to be misquoted in favour of absolute conformity, of the abstract average against the real individuals. The habit of determining what we should think, by discovering what most of us *do* think, seems to be growing upon us; with whom doth *Time* Gallup withal, quoth Rosalind.

Paulo minora canemus. There is yet another, lesser, danger to be considered. In pure science, more than in any other profession, it is the rule that thorough training must involve personal participation in research. Nearly all scientists, then, and not merely those who hold university appointments, have made the difficult transition from undergraduate to graduate study. There are many difficulties at this point, for a whole new set of qualities (independence, dexterity, cooperativeness) is suddenly demanded of the student who has, till then, depended largely on clarity and memory; but the greatest difficulty is a violent change in perspective. In the undergraduate course the student has dealt rapidly with vast tracts of science; he has little conception of the vast amount of knowledge out of which his textbooks are distilled. I remember very well that, as a freshman in zoology, I thought I could reasonably be expected to know the whole content and every detail of that science when I came to graduate; I did not dream that there were 500,000 species of insects alone. One is less naive when one enters a graduate school; but it is still a terrific shock to be handed

some small problem and to discover that a dozen men have touched on it before, with varying conclusions; that one will work upon it for three years, and count oneself lucky to be quoted in a dozen subsequent papers; that one might work on it for a lifetime, and not be sure of saying the last word, nor of winning a single sentence in the textbooks of the future. The undergraduate is shown the vast terrain of science, as it were through a telescope held wrong way around; he sees the broad geography, but none of the details. Now the telescope is reversed; is it surprising if he loses his landmarks? The cheerful generalizations he enjoyed become suspect and fallacious; he is overwhelmed by the thought of "the lyf so short, the craft so long to lerne"; he does not hold an opinion on any subject but his own tiny one. This often produces very dull dogs, and poor teachers, yet it is sometimes a salutary discipline. "Versatility," says E. H. Neville, "is the most delusive of the fairy gifts; the men of genius on whom it was bestowed otherwise than in subtle malevolence can be counted on the fingers"; and indeed it is better for those who aspire to being "tigers" in research to abjure the cult of versatility. We owe most of the great advances to specialists; but it would be a dull world if there were no butterflies.

In deference to my title, I must conclude by saying *something* of that type of scientific work which is aimed at increasing the material prosperity of our own country. Let me point out only that the word "prosperity" requires careful definition; it is a comfortable word if we do not look too closely. At first sight it seems that every advance in agriculture must mean that more food is produced; but in fact the whole tendency on this continent has been rather to produce the same amount of food with less labour, and hence with fewer persons to share the proceeds. The European wheat-farmer gets a higher yield per acre than we do; but of course he has far fewer acres, and hence a lower standard of living. So also many advances in manufacturing that seem calculated to increase national productivity turn out to be merely means of reducing the number of employees. One might even say flippantly that advances in medicine, since they have chiefly reduced mortality in the lower age-groups, turn out to be essentially methods of maintaining the population with fewer births—again a type of reduction of labour!

The moral of these thoughts on prosperity is exactly the same as the moral of all the previous sections of this address: that science, by itself, is not enough. Every advance in science demands, but rarely evokes, corresponding advances in economics or politics or sociology; without these there is maladjustment, and what should be harmonious growth to gigantic national stature may become grotesque hypertrophy of a single limb. The scientific is the most powerful method yet devised for making the universe comprehensible to our limited minds; but it is only one of several methods. Let us not exaggerate it; but let us not

depreciate it. Its greatest achievement, material possessions apart, has been its power to awaken curiosity and the spirit of enquiry in tens of thousands of young minds. In this widespread curiosity, this challenge of the unknown, we see the hall-mark of our age and hope for the future. The strange old legend of the Holy Grail, which owes so little to Christianity despite its odour of sanctity, tells us that the wandering champion had only to ask a question of his host to ensure a happy ending. Had the question been asked, the Fisher King would have been healed of his long sickness, and the Waste Land would have become green and gracious. Let us not fall into the silent error of Sir Gawain; let us ask our questions, of the man-made world as well as of the natural world, and who knows what miracles shall answer us?

Abdominal Pain

By WILLIAM WALSH, '48

PAIN in the abdomen is one of the most common of diagnostic problems encountered in medical and surgical practice. An understanding of the production of abdominal pain, coupled with a knowledge of the types of pain from the different abdominal viscera, will help the clinician on the road to diagnosis.

The purpose of this paper is to review the work concerning the anatomical and physiological basis of abdominal pain, and to discuss the mechanisms of the common pain pictures. Brief reference will also be made to the extra abdominal causes of abdominal pain.

Modern thought concerning visceral pain began in 1883 when Sturge explained the radiation of animal pain as resulting from the extension of sensory impulses in the grey matter of the spinal cord. Ross followed Sturge's reasoning to explain visceral pain in general. In the abdomen he called it splanchnic pain. However, Lennander and MacKenzie came to the conclusion that the viscera were insensitive. This was because at that time they were unaware of the appropriate stimulus. Thus they denied the hypothesis of Sturge and Ross, and proceeded to explain visceral pain as the result of non-painful impulses ascending from the viscus to the cord. In the cord these impulses, according to MacKenzie, spread to the sensory tracts, and set up pain referred to the peripheral territories of these tracts. Today MacKenzie's theory of referred pain has been modified as described in the ensuing discussion. Further, the existence of true parietal pain is now accepted. This is the pain that arises when the disease process spreads to involve the parietal peritoneum.

True abdominal pain can be described under two headings. First is true visceral pain carried by the autonomic nervous system. The second is local parietal pain and its referred phenomena carried by the somatic sensory system.

Pain from the hollow abdominal viscera arises only upon the appropriate stimulation, which is the stretching or violent contractions of the visceral musculature. Since the pain arises with the muscle contractions, it is colicky in character. Further it decreases as the contracting viscus becomes fatigued and contracts less forcibly. The reference of this pain is deep-seated, diffuse, and tends to remain medial. It is segmental in character. The nervous impulses arise from the viscus and are carried by the visceral afferents (usually through the sympathetic trunks) through the grey rami communicantes and the posterior

roots to the spino-thalamic tract. It is very important to note that the visceral sensory fibres follow the same tract in the central nervous system as do the somatic sensory fibres supplying the abdominal wall and peritoneum. Finally the impulses ascend to pass through the thalamus to the cortex, where actual perception is initiated. The perception of the sensation produced is referred to the peripheral distribution of the segment in which the affected viscus lies. Chester M. Jones suggests that there may well be a summation of the stimuli arising from the various parts of a given segment, and that the aggregate of which must exceed a certain total before perception occurs. Since the nerve supply arises from the segment from which the viscus has migrated in embryological development, the visceral pain is also referred to this level.

James C. White has reviewed observations on the pathways of visceral pain, made directly on man. He has correlated anatomical description with knowledge gained from experimental stimulation of human viscera, resection or chemical block of autonomic ganglia and trunks, and the interruption of posterior spinal roots. His conclusion can be stated as follows: Stomach pain is carried by the splanchnic nerves T7 to T9. Gall bladder and biliary apparatus pain by the right splanchnic nerve. Pain from the duodenum and jejunum by the splanchnic nerves. Pain from the small intestine is also carried by the splanchnic nerves to T9 to T11. The exact pathways for the pain of the colon are not definitely known. White has considered that the fixed portions of the colon get their sensory supply from the intercostal and other somatic sensory nerves. The afferent pathways from the transverse and sigmoid colon to T11 and T12 are not known, as the sense of distention persists after splanchnicectomy and ganglionectionomy from T9 to L9. The rectum gets its sensory supply from parasympathetic rami from S2 to S4. Pain from the renal pelvis is by the lower splanchnics and regional sympathetic ganglia from T10 to L1. The ureter is by the renal and ureteral plexuses to T11 to L1. The trigone, prostate, and urethra by the pelvic nerves to S2 to S4. The testicle has a more complex sensory supply by the sacral nerves to S2, S3, and S4, the genito-femoral nerve to L1 and L2, and the spermatic plexus to T10.

The second type of pain arising from the pathology of an abdominal viscus is known as local parietal pain or true somatic pain. MacKenzie believed the peritoneum to be insensitive, but the extra peritoneal connective tissue to be sensitive. Today we know that the parietal peritoneum is highly sensitive to both stretch and inflammation. This pain is characteristically sharp, well-localized, and stabbing in quality. Once the focus of irritation is established, the patient tends to be very still, rather than to move about as with a colic. The parietal peritoneum is innervated by the same somatic nerves that supply the overlying

muscle and skin. This includes the peripheral part of the diaphragmatic peritoneum and excludes the pelvic peritoneum. This common innervation gives rise to the phenomena of deep tenderness, muscle rigidity, and cutaneous hyperalgesia.

The peritoneum over the central part of the diaphragm is innervated by the phrenic nerve, thus mechanical or inflammatory stimulation produces pain referred through the third, fourth, and fifth cervical segments via the supraclavicular nerves. This results in pain perceived along the upper border of the trapezius. Diaphragmatic pain differs from true parietal pain in the loss of direct pain perception from the diaphragm due to the embryological migration of this structure. The peripheral part of the diaphragm gets its sensory supply from the intercostal and subcostal nerves. Stimulation of this part of the diaphragm results in poorly localized pain over the lower thorax and upper abdomen. Associated with it is muscular rigidity and cutaneous hyperalgesia. Diaphragmatic pleurisy and peritonitis both will give rise to this. Thus the aphorism, "The differential diagnosis of the acute abdomen must include lower lobe pneumonia".

The parietal peritoneum proper is innervated by the somatic sensory nerves from the seventh to twelfth thoracic and first lumbar segments. Here pain is localized at the point of stimulation. The mesenteries of the small and large intestines are sensitive from near the roots to near the intestine, whereas the greater omentum and visceral peritoneum are insensitive to mechanical stimulation. In the mesentery, free endings of myelinated nerves persist after section and degeneration of the vagus and splanchnic fibres. Evidently these endings are responsible for the sensitivity of the mesentery and are derived from the somatic nerves supplying the parietal peritoneum. Thus when the pathology in a viscus involves the parietal peritoneum it results in a steady, stabbing pain localized directly over the viscus. The muscle rigidity is a reflex, localized, protective muscular spasm initiated by irritation of the parietal peritoneum. Deep tenderness is not a referred phenomenon, but a direct sensation from the inflamed peritoneum.

Schutz has amassed a great deal of evidence indicating that the cause of cutaneous hyperalgesia depends on the intimate relationship between the somatic sensory nervous system, and the sympathetic nervous system. When stimuli arise in the somatic sensory system at an abnormally rapid rate, the corresponding segment of the sympathetic is reflexly excited, producing phenomena in the common peripheral segment. The milder manifestations are spontaneous skin pain and hyperalgesia. The more severe ones are redness, heat, oedema, and even vesiculation. Peritoneal irritation, herpes zoster, nerve injury, and abnormal pressure on nerve root or trunk, are some of the conditions that may initiate this reflex.

STOMACH PAIN

Lucas has found that in cases of gastric pain, relief has been obtained completely by alcohol injections into the splanchnic nerves, but the relief has been incomplete in injection of the vagus trunks. Some reports on the results of vagotomy indicate that pain relief is due to decreased spasm that is initiated through the vagus nerve. However, there is still much debate concerning the exact etiology of ulcer pain. Palmer maintains that the inflammatory reaction in the ulcer area covers the pain threshold of nerves surrounding the ulcer, so that mechanical or chemical stimuli produces pain. Jones believes that the ulcer produces enough oedema and spasm to be equivalent to the usual adequate stimulus—bowel distention.

Pain, and its reference from the gastro-intestinal tract, has been described by Jones in his classical experiments in which he introduced a balloon to descend through the gut and be inflated at various levels. His observations agree essentially with the old clinical observations of MacKenzie. Because of technical difficulties, he made no direct observations on the stomach, but the work of other investigators all point to the fact that the reference of pain from the stomach is epigastric. Distention of the duodenal cap produced midline or right epigastric pain sharply localized. As stimulation in the duodenum proceeded downwards, it was definitely noted that distention of the mid or lower portion of the duodenum produced localized midline pain in the low epigastric or high umbilical zones. Apparently without exception distention of the jejunum and ileum caused umbilical pain that was fairly well localized in the midline, pain from the jejunum being felt at a little higher level than that from the ileum. At the ileocecal valve, distention produced pain at McBurney's point, with radiation to the epigastrium. In general, distention of colon produced a less well localized, but definitely uncomfortable sensation, that was for the most part referred to the hypogastrium near the midline. A noticeable exception to the midline rule was found in stimulation of the hepatic and splenic flexures, and the sigmoid, when in these places pain was noticed over the part distended. Distention of the rectosigmoid produced suprapubic or sacral pain. These were the references found in normal individuals, but some exceptions were found in sensitive subjects. Often the pain was referred to the back, along with the anterior pain. In a few the pain had a "belt-like" segmental distribution.

GALL BLADDER PAIN

Biliary colic is an agonizing prostrating pain, sudden in onset and cessation. As a true visceral pain, it comes and goes synchronously with waves of hyperperistalsis. It is felt in the epigastrium but often radiates to the infrascapular region. The impulses are transmuted through the right splanchnic nerve. The pain picture further depends

on whether there is an associated inflammation of the sensitive parietal peritoneum. Zollinger noted that distention of the gall bladder in patients coming out of anaesthesia produced deep epigastric pain, except when the gall bladder was actually pushed against the parietal peritoneum, in which case there was a sharp, steady pain over the point of contact.

There has been much debate concerning the mechanism of the radiation of biliary tract pain to the infrascapular area. Many believe the pain to be referred by the autonomic nervous system. However, Morley claims that the radiation is never seen with the first attack of colic, before there is an associated pericholecystitis. Alvarez is drawn to the conclusion that it is due to the irritation of the posterior peritoneum.

Abdominal pain arising from the solid organs of the abdomen has a slightly different origin. The capsules of the spleen, liver, and kidneys contain sensory fibres. When the organ is distended by passive congestion or by inflammation, the clinical manifestation is tenderness and dull pain. Schutz claims that there is little, if any, spontaneous pain. Heaviness or dragging sensations are probably due to pull in the mesenteries.

Finally, a few words should be said about pain arising from the urinary tract. Kidney pain may be felt in front of the loin, just below and external to the junction of the linea semicircularis and the costal margin, as well as posteriorly in the angle between the twelfth rib and outer border of the erector spinae muscles. The pain of renal colic begins in the above described area and may radiate to the testis or labia. Lewis refutes the old idea that the radiation of the colic localizes the stone. He states that the whole picture may be seen with a stone fixed in the upper end of the ureter. Renal colic is different from other abdominal visceral pain in that it is not located medially and it radiates in a non-segmented manner. The reason for this might possibly be found in the fact that the ureter has not a midline embryological origin like the biliary apparatus and gastro-intestinal tract, but rather originates as a bud from the laterally placed mesonephric duct. The bladder may give rise to true visceral pain localized in the abdomen above the pelvis, and due to distention. True somatic pain may arise from the trigone when it is stimulated by stones, tumour, or inflammation. It is characteristically sharp, well localized, with radiation to the tip of the pubis or clitoris. Since the testis originate in close embryological association with the kidneys, they give rise to a dull, sickening pain which radiates in a reverse direction to kidney pain, sometimes as high as the lumbar area.

The preceding principles can be applied in interpreting most pain syndromes in the abdomen. An excellent example of this is seen in a

typical case of acute obstructive appendicitis. The first pain is the visceral pain that is colicky, periumbilical, and due to distention and hyperperistalsis. As the muscle fatigues, this primary pain decreases, and at the same time the inflammation involves the parietal peritoneum, producing the secondary, constant, sharp, localized pain associated with tenderness, rigidity and often cutaneous hyperaesthesia.

Similarly, we can interpret the hypogastric cramps of obstructing rectosigmoid carcinoma; the epigastric colic seen with duodenal spasm; the primary epigastric distress of biliary colic due to hyperperistalsis or distention of the biliary tract, and the secondary subcostal pain with radiation due to peritonitis.

EXTRA ABDOMINAL CAUSE OF ABDOMINAL PAIN

Acute infections, especially in children, may give rise to abdominal pain as an initial symptom. It is due to an autonomic imbalance or an associated lymphadenitis.

Neurogenic disorders often produce abdominal pain. A classical example of this is the gastric crisis of tabes. It has been attributed to vagal storm by some, and to a sympathetic dysrhythmia by others. Abdominal pain may accompany many types of brain disease, including vasospasm, tumour, encephalitis, migraine, and the epigastric aura of convulsive states. Wechsler has contended that the source of neurogenic abdominal pain is the cerebral cortex, probably the premotor area. He adds that the hypothalamus and possibly the vagal nuclei may mediate or initiate the cortical response.

Cardiac pain is due to the heart muscle contracting under anoxic conditions. This pain is intensified by the reflexly increased tonus of the intercostal musculature. This occurs through the intercostal nerves, which also supply the anterior abdominal wall, and may produce splinting of the epigastric musculature. The pain may be referred as low as the umbilicus.

Many metabolic disturbances produce abdominal pain. Acidosis, especially when associated with diabetes, is not an uncommon cause of abdominal pain. The mechanism is believed to be similar to that of heat cramps or gastric tetany, with their associated loss of sodium chloride from the extracellular fluid. Supposedly the contraction of abdominal muscles in the abnormal physiological state causes the pain, as it does in heat cramps.

Hypoglycemia, according to Sandler, in some individuals has a tendency to stimulate a group of neurons in the vagal nucleus. When this takes place, the segment of the gastro-intestinal tract (including the biliary apparatus), innervated by these neurons, undergoes a strong contraction which may go on to tetany. This produces abdominal pain.

Uncontrolled thyrotoxicosis may produce either a diffuse, colicky abdominal pain, or more commonly one which is localized in the lower right quadrant.

Lead poisoning may give rise to a colic that is paroxysmal and excruciating. The pain is due to the intense spasm of the intestinal musculature. The lead probably acts directly on the musculature.

Some investigators feel that the accumulation of irritant metabolites in tissues is capable of producing pain. This accumulation is usually associated with vascular disease or spasm; according to Schutz this might well account for the pain of mesenteric thrombosis.

SUMMARY

I. True visceral pain is deep-seated, central, colicky, and poorly localized. There are no associated referred phenomena, according to most authors.

II. True somatic, or local parietal pain, is sharp, stabbing, constant, sharply localized, and associated with the referred phenomena of muscle spasm and hyperalgesia.

III. Thoughts concerning the etiology of pain from important individual viscera have been reviewed.

IV. Brief mention has been made to some of the extraabdominal causes of abdominal pain.

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The Early Diagnosis of Cancer

By JOHN COLES, '48

THE medical profession and the laity, alike, have been warned of the necessity of the early diagnosis of cancer. Up until the present time it has been necessary to depend upon symptoms, which, by demanding further investigation, ultimately lead to the diagnosis of malignancy. With the advent of modern radiography our suspicions are aroused, in many cases of cancer, of the various symptoms. However, the expense of such examinations precludes this use routinely.

Various workers have attempted, since time immemorial, to find a simple test which would allow a diagnosis of cancer to be made. Of necessity, with such a problem and the laurels its discoverer would receive, there has been stimulated numerous research in this field, some scientific, some otherwise. We would also expect many claims of success; however, none have passed the test of time.

As early as 1847 Pauchet had studied vaginal smears for the purpose of analyzing the normal human sex cycle. However, he used unstained smears and was unable to make accurate diagnosis. Papanicalaou, in 1917, derived a staining technique whereby greater accuracy could be made. He applied his staining methods to vaginal smears in the study of the human sex cycle. His research in this field led to the isolation of the estrogenic hormone. In 1923 Papanicalaou began a vaginal smear study at the Women's Hospital (New York), on women with normal and abnormal menstrual cycles. In 1928, and later in 1933, he published the results of his investigation. In some cases he had found atypical cells which were later proven to be malignant. Curiously enough, no one, not even Papanicalaou himself, recognized the great potentialities of his discovery and he went back to the study of sex physiology for the next seven years.

At about this same time Papanicalaou became associated with two eminent gynaecological pathologists, Dr. Trout and Dr. Marchetti. They worked on the problem as a group and in 1943 published the results of their endeavour to diagnose uterine cancer by the vaginal smear technique.

In a group of 127 patients with demonstrable malignant lesion of the cervix, in only 3.6% was there a failure to diagnose malignancy by the smear technique.

In a group of fifty-three patients with adeno-carcinoma of the fundus there was a failure to diagnose in 9.3% of the cases.

In November, 1946, Papanicalaou and Marchetti introduced the endocervical and endometrial smear test. This modification increased the accuracy of the technique. They reported a case history to illustrate their point.

A woman was admitted to a New York hospital on July 26, 1948. Vaginal and endometrial smears were prepared. A carcinoma was diagnosed by the endometrial smear; however, the vaginal smear contained only normal cells. On August 6 a cervical biopsy and a dilatation and curettage were done. They showed only a normal endometrium and a chronic cervicitis. After these procedures one would be tempted to feel secure, especially in the absence of definite clinical symptoms. However, on August 28 the endometrial smear was repeated. Again it showed malignant cells, and cancer was again the diagnosis. On August 30 it was decided to do a total hysterectomy. This revealed a primary carcinoma of the Fallopian tube. This report created a widespread unrest, with the result that a Harvard Medical School group—Doctors Meigs, Fremont, Smith and Graham—conducted an investigation of the test on 1,015 cases. They reported a total error in the diagnosis of cancer of the uterus by the smear test of only 4%. Since that time, numerous similar reports have been made by various workers throughout America.

With such encouraging results, it was only logical to utilize the smear test in the diagnosis of malignancies of other systems of the body. Thus we find in the literature reports of the diagnosis of:

1. Genito-urinary malignancies by examination of sediment from centrifuged urine.
2. Broncho-genic carcinoma from sputum and bronchial secretion.
3. Stomach carcinoma from examination of gastric juice samples.
4. Malignant cells in pleural and peritoneal fluids.
5. Cancer of the rectum by examination of rectal mucus.

The results reported by Papanicalaou on the examination of urine sediment were not quite as spectacular as those of the vaginal smears, having 3.7% false positives and 40% false negatives. It is of interest to note, however, that in some cases the specific type of tumour and its approximate location were accurately estimated. Thus included in his cases were Wilm's tumours of the kidney, squamous cell carcinoma of the renal pelvis, carcinoma of the bladder and carcinoma and sarcoma of the prostate. Papinacalaou also claimed to be able to assess the results of estrogenic therapy on carcinoma of the prostate by the changes observed in the smears on repeated examination.

Papanicalaou was not the first man to diagnose cancer of the urinary system by examination of the urine. In 1864 Sanders had described

shreds of cancerous tissue in the urine. Since then, several workers have contributed to the literature on similar observations—such as Ferguson in 1892, Stenius in 1925, and Mulholland in 1931. As previously mentioned, Papanicalaou re-established interest in urine sediment in 1945.

Dr. Dant of Mayo Clinic, in September of this year, added to the diagnostic value of the smear technique in studying centrifugal urine. He advocates the use of a fat stain, Sudan IV, in the differentiation of fatty from non-fatty tumour cells. Thus primary fatty tumours, such as carcinoma of the prostate and hypernephroma, can be distinguished from carcinoma of the vesical neck and epithelioma of the renal pelvis.

He also has added a polychrome methylene blue staining technique. This apparently is as good as the Papanicalaou stain for immediate examination of the specimen; however, it fades out after about ten days. Dr. Dant claims that cytology rather than morphology are utilized almost solely in the diagnosis.

DIAGNOSIS OF CANCER OF THE LUNG

As early as 1887 Hamplen had made an attempt to diagnose lung cancer by examination of the sputum. In 1935, Dugeon and Wrigley attacked the same problem. They fixed the sputum in Bichloride solution and then stained it with Hematoxylin and Eosin.

In 1944 Wandall, of Copenhagen, using Dudgeon's technique, reported a series of 250 cases in which, out of 193 positive results, only 3.1% were false. In another series of 100 proven cases of bronchogenic carcinoma, in 84% malignant cells were found in the sputum. In this same series only 55% of bronchoscopic biopsies showed malignant tissues.

Wandall emphasized the need for a sufficiently large number of cells to make it possible to appreciate nuclear variation from cell to cell. He also warned that atypical macrophages and epithelioid cells found in tuberculosis patients were likely to confuse the tissue.

Clerf and Herbert, in the November issue of *Medical Clinics of North America*, state that in a series of fifty-seven cases of proven bronchogenic carcinoma, 82.4% were diagnosed by the Papanicalaou smear technique alone, using bronchoscopically-removed secretions to lessen the factor of dilution of sputum by saliva. In this same series only 42% were diagnosed by bronchoscopic examination.

Woolver and McDonald of the Mayo Clinic have recently published results of their first seventy cases extensively studied. They concluded that a positive result from examination of sputum as bronchial secretion could be expected in at least 80% of the cases of lung malignancy.

However, they added that a negative result does not rule out carcinoma.

They also found that in cases of bronchogenic carcinoma (which make up 90% of all lung tumours), the Papanicalaou smear would detect a very high percentage of them (probably over 90%). This they attributed to the fact that there is a constant exfoliation of cells from the free surface of the neoplasm. In the very small minority of cases with negative results, the tumour was usually located in the periphery.

The second group of broncho-pulmonary tumours consists of the bronchial adenomas and the cylindromas—which comprise about 10% of the total. In almost all of these cases negative results were obtained.

Woolver and McDonald also give a good account of the various cells found in the sputum. They are classified as: (a) benign cells, (b) malignant cells. The benign cells are divided into three categories:

- (1) *Epithelial Cells*—These are quite common. They arise from the mouth, pharynx, trachea and bronchi.
- (2) *Macrophages*—These are the phagocytic cells of the lungs. By reason of their phagocytic character they are readily distinguished from malignant cells.
- (3) *Inflammatory Cells*—These include polymorphs, lymphocytes and plasma cells.
- (4) *Epithelioid Cells*—These are occasionally seen in T.B., and a large number of eosinophils might be expected in cases of bronchial asthma.

MALIGNANT CELLS

In general they are larger than normal cells (with the exception of highly malignant oat-cell or small-cell cancer). Very important is the variation in size—*anisocytosis*—and especially the variation in size of the nucleus—*anisonucleosis*. Also the variations in shape of the cell and nucleus—*poikilocytosis* and *poikilonucleosis*—the hyperchromaticity, and in short all those features which characterize malignant tissue in general, with the exception of *invasiveness*.

In the microscopic study of tumours of the broncho-pulmonary system there is a classification into three types; likewise malignant cells in the sputum can often be similarly classified. Thus we have: (1) oat-cell cancer, or small-cell cancer—a very anaplastic type; (2) squamous cell cancer; (3) adeno carcinoma.

GASTRIC FLUID SMEARS

Gastric fluid smears contain many desquamated cells, such as those derived from the epithelial lining of the oesophagus, occasional ciliated

respiratory epithelium, and most interesting of all are those pigment-laden leucocytes which have taken origin in the lungs. They evidently enter the stomach with mucus which is swallowed.

Papanicalaou, in a preliminary trial of nine suspected cases, diagnosed two as adeno-carcinoma by the smear technique. The other seven were negative. All were later proven by operation or other methods of investigation to be diagnosed correctly by the smear. Papanicalaou concluded at this time that cancer of the stomach could be diagnosed with a fair degree of accuracy by his smear technique.

EXAMINATION OF DUODENAL FLUID

Although very little work has been done in this field, it seems logical that on occasion carcinoma of the gall bladder, bile ducts and duodenal papilla, and even carcinoma of the head of the pancreas, may be diagnosed.

EXAMINATION OF RECTAL MUCUS

Probably at least 50% of carcinoma of the colon is located in the rectum. By the same technique as in other systems, Papanicalaou smears could be made, therefore one could imagine that the smear test would be of aid in the diagnosis of carcinoma of the rectum.

THE PAPANICALAOU TECHNIQUE

Varies only slightly in the preparation of smears from the various sources.

The fluid is aspirated with a glass pipette, spread evenly on a slide and immediately fixed in a solution of equal parts of 95% alcohol and ether. For endometrial or endocervical aspirations a special flexible metal cannula is used. For urine tests, 40 c.c.s of catheterized specimen is usually employed. It is then mixed with 95% alcohol and centrifuged. Smears are then prepared from the sediment and fixed in alcohol ether. For gastric aspirations and peritoneal and pleural fluid specimens the same technique is used. For sputum examination a specimen obtained after coughing is found to be best. This is fixed immediately in 90% alcohol. Smears are made from this and then placed in alcohol-ether solution. All smears are stained with hematoxylin and then with Papanicalaou's special counterstains. These counterstains, according to Papanicalaou, have the advantage of being transparent and giving good eosinophilic and basophilic cells.

Since 1944 the application of the Papanicalaou technique to the smear diagnosis of cancer of the various systems has spread rapidly; thus, by December of this year, the literature has become studded with reports of results in the various clinics. Although not all of the reports have had results with a percentage of error as low as those of

Papanicalaou in New York and Meigs in Boston, they are for the most part very encouraging, so much so, in fact, that most of the larger teaching centres are employing the smear test in selected cases and some are using them routinely.

An interesting modification of the Papanicalaou smear technique has been advanced by Richardson and Hunter of Portland, Oregon, in the September issue of J.S.G. & O. The results of their studies have been better than many of the other reports, and they approximate closely those of Papanicalaou. These workers found they could not get even smears when using Papanicalaou technique, and also that the time consumed in studying the slides was at least twice as long as that required for an ordinary pathological section. Their first modification came from Dr. Melvin Breese, their resident in Gynaecology. He advocated that:

- (1) A warm, dry speculum without lubrication be used.
- (2) The speculum be brought to as nearly a horizontal position as possible.
- (3) The fluid in the post-cervix be gently milked into the speculum.
- (4) Smears be made by dipping a gloved finger into the fluid and making a rapid longitudinal streak on a glass slide. He stressed the necessity of avoiding the natural tendency towards a circular motion of the fingers.
- (5) The smear be then placed directly in the Papanicalaou alcohol-ether solution.

While this modification was of some improvement, it did not eliminate all the difficulties. One day, when confronted with an abnormally thick smear, Hunter noted that flakes had dropped off into the fixing fluid. He embedded these bits of tissue in paraffin, sectioned them, and then used the Papanicalaou stain. Much to his amazement, the cytologic details were perfect. Thus these workers realized the possibility of concentrating these cells, lessening the space between them and thus saving considerable time during the microscopic examination.

Saturated picric acid proved to be the agent which would precipitate proteins and mucus and at the same time act as a fixative. It was also inexpensive and easy to prepare. The solution is then passed through a filter paper to separate the precipitate. The precipitate is then pressed into the cone of the funnel with a glass rod. From then on it is handled like tissue embedded in paraffin.

The advantages of this modification (according to the authors) are:

- (1) the cells are well preserved; (2) they are concentrated, thus

alleviating the necessity of a long search over wide areas; (3) Papanicalaou stain can be employed; (4) all cells are in the same focal plane; (5) groups of cells are not likely to be torn apart as in the smear technique, and cell patterns can be made out.

SUMMARY

By the cytologic examination of exfoliated cells, using the Papanicalaou technique and some of its modifications, a rather high percentage of neoplasms can be diagnosed, often before symptoms are manifested.

The Advantages of the Test (According to Papanicalaou)—

1. It is simple and inexpensive.
2. It is reliable in the hands of experienced men.
3. It permits the early diagnosis of incipient cases or of hidden carcinomas, such as in the diverticula of a bladder. This is because aberrant cells become exfoliated from the surface of a cancerous growth even before it is ulcerated.
5. It does not conflict in any way with established methods of diagnosis, such as biopsy or curettage, being on the contrary a valuable complement to them, as it covers a far larger area. In respect to curettage of the uterus in presence of adeno carcinoma, some workers feel that this procedure is definitely contra-indicated. They claim that the curettings may pass out the Fallopian tubes, through the uterus into the peritoneal cavity (as the uterus is usually quite soft in adeno carcinoma) or open into blood sinuses.
6. The test may in some cases reveal the presence of cancer where biopsy has failed.
7. It is of unique value in following up the results of operative procedure, or the progress of irradiation or other methods of therapy.

Disadvantages of the Test—

1. Its criteria are not clearly standardized.
2. The type and origin of malignant cells are not always clear.
3. It is difficult to estimate the grade of malignancy.
4. It does not supply information as to the activity of the growth.
5. The average time required for the examination of a smear is somewhat longer than that required for a pathological section. This perhaps does not apply when Hunter's modification of the test is used.

STATUS OF THE TEST IN VAGINAL SMEARS

As to the accuracy of the test in vaginal smears, from a review of the literature we can say that in experienced hands there are approximately only 4% false positives; however, the percentage of false negatives, although not definitely known, is probably much higher, even up to 40%. Thus when the vaginal smear test is positive it is of much more significance than when the test is negative.

When the endocervical and endometrial aspirations are used, the percentage of errors is probably even less. However, it seems that much of the simplicity of the test is lost and, after all, the introduction of a foreign body into the cavity of the uterus requires an operating room and absolutely sterile technique; even then it is not without dangers.

STATUS OF THE TEST IN BRONCHO-PULMONARY NEOPLASMS

Here again, from present literature, we can conclude that the study of malignant cells in the sputum and bronchial secretions is a useful adjunct in the diagnosis of bronchogenic carcinoma.

As would be expected, the test is of special value in lesions of the lung remote from the reaches of the bronchoscope—such as lesions in the upper lobes and in the smaller air passages.

This method is also of special importance in the establishment of a diagnosis in such cases where bronchoscopic examination is contraindicated.

A positive result may be obtained in 80% of the cases of bronchogenic carcinoma. False positives reported by most workers vary from 1% to 3%.

Thus the cytologic examination of the sputum, if we can depend upon statistics, is a more reliable diagnostic aid in cancer of the lung than vaginal smear is in diagnosing cancer of the uterus.

Here again, however, a negative result *does not* necessarily exclude the possibility of the presence of a malignancy.

STATUS OF THE SMEAR IN THE URINARY TRACT

In the urinary tract, as well as the others, it can be said that the advantages of the test far outweigh the disadvantages. As investigators gain more experience, the test should become of even greater aid to the urologist and the pathologist.

STATUS OF THE TEST IN RECTAL MUCUS AND GASTRIC AND DUODENAL LAVAGE

The test appears to be of value here also. The few reports in the literature on these particular applications seem to be encouraging. Undoubtedly the paucity of reported results will be remedied by time.

CONCLUSIONS

In concluding this paper, may we draw attention to the potentialities of the smear test in the diagnosis of malignancies. Here we certainly have an aid to the early diagnosis of cancer, and in some cases it may be the only evidence we can find.

As Papanicalaou has stated, the application of cytologic examination to the fluids bathing the various systems is only logical, as the exfoliation of cells is but an example of nature's own method of curettage.

Thus, in carcinoma of the uterus, lung and stomach, the triad of death in internal cancer where diagnosis in the early stages is difficult, it would seem even the most astute clinicians will welcome evidence furnished by the smear test.

Now, just before closing: So often in the literature we get only the reports of the enthusiasts; this may be so in regards to the Papanicalaou smear.

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SUMMER DIARRHEA IN BABIES

Casec (calcium caseinate), which is almost wholly a combination of protein and calcium, offers a quickly effective method of treating all types of diarrhea, both in bottle-fed and breast-fed infants. For the former, the carbohydrate is temporarily omitted from the 24-hour formula and replaced with 4 packed level tablespoonfuls of Casec. Within a day or two the diarrhea will usually be arrested, and carbohydrate in the form of Dextrin-Maltose may safely be added to the formula and the Casec gradually eliminated. One to three packed level teaspoonfuls of a thin paste of Casec and water, given before each nursing, is well indicated for loose stools in breast-fed babies. For further information, write to Mead Johnson & Company, Evansville 21, Indiana.



AN APPROACH TO SOCIAL MEDICINE

By JOHN D. KERSHAW, M.D., D.P.H.

WILLIAMS & WILKINS, BALTIMORE, 1946, pp. 329, PRICE \$4.50

"Man is a social animal." With that thought in mind, Dr. Kershaw traces the growth of society, as we know it today, from its most primitive and basic form, the family, to the more complex social entities—the community, state and occupational groups—describing how each arose from the problems and complexities of preceding groups. With the structure or "Anatomy of Society" firmly established, the reader's attention is turned to the "Physiology of Society", the development of the monetary system, the individual's contribution to society, the growth of government, and with it law and order. But, like the human body, society does not always function in a normal and orderly manner and, as the author points out in the second portion of the book, the disorders and disharmonies of society are often equally severe and are frequently responsible for disorders of the human body.

The second half of the book is devoted to the part which medicine and its various branches play in society. We have, for example, "The Social Problem of Surgery", in which Dr. Kershaw states his belief that the surgeon should follow his patients' progress as they attempt to re-establish themselves. Society, on the other hand, should aid the surgical patient by the provision of rehabilitation centres and industry should permit the patient to return to his old work under reduced pressure or provide "lighter" work for him. In a similar manner he deals with Public Health, Industrial Medicine, The Problem of Food, of Housing, The Problem of the Handicapped, and other related topics.

Dr. Kershaw's little book makes excellent reading, for its language is simple and non-technical. It does not attempt to offer solutions to the many problems society offers medicine, but rather it attempts to outline those problems in a clear, concise and logical manner, suggesting possible solutions in some cases, but often leaving the reader to find his own answer. This is a book that is readily recommended to anyone anxious to get a better conception of the growing and all-important field—Social Medicine.

—G. L. NANSON, '50.

NATURAL HISTORY OF NONSENSE

By BERGEN EVANS

RYERSON PRESS, TORONTO, 1946, pp. 275, PRICE \$3.50

People of today's scientific age, where, supposedly, the scientific method is applied extensively in all reasoning, are prone to have a rather exaggerated notion of their ability to think without prejudice and free from preconceived ideas, and analyze their beliefs scientifically. They may even pat themselves on the back and thank heaven that civilization has outlived the primitive age of superstition, when many of man's actions were governed by fear stemming from a lack of understanding.

"We may be through with the past, but the past is not through with us. Ideas of the Stone Age exist side by side with the latest scientific thought."

These are the opening words of Bergen Evans' first chapter. Since the above condition is essentially true, he says that he intends his book as a handbook for young recruits in the gay cause of common sense, and he goes on to prove beyond a doubt that common sense is alarmingly uncommon.

The main point of "The Natural History of Nonsense" consists of the examination and exposure of countless widely held concepts—ideas which we hear expressed frequently by the uneducated and college professor alike. He shows the incongruity of much of our everyday thinking by comparing prevalent ideas with others of a similar nature which we recognize as being obviously ridiculous. This method of comparison which the author has made use of enables him to achieve a subtle humour which holds the attention of the reader very effectively. Furthermore, the reader cannot fail to realize that he himself has been guilty of blindly accepting some of the bug-a-boo which the writer exposes.

The scope of this book is extremely wide and varied. It deals with everything, ranging from whether or not God gave Adam and Eve navels, which are held by some to be useless appendages and hence incapable of being bestowed by the Almighty, to the question of whether or not Negroes are continually beset with such sensuality as to make them a menace to society.

Evans warns in his final chapter, "Civilization has a moral obligation to be skeptical, to demand the credentials of all statements that claim to be facts." Until you read his book you will not realize how painfully primitive civilized man still is in some of his concepts or how ridiculously rash he is in accepting ideas that suit his taste or prove his point.

—TREVOR SANDY, '50.

RECOLLECTIONS OF MY LIFE

By SANTIAGO RAMON Y CAJAL — *Translated by* E. H. CRAIGIE

UNIVERSITY OF PENNSYLVANIA PRESS, PHILADELPHIA, 1937,
pp. 638, PRICE \$5.00

"This time light comes from the south, from noble Spain, the country of the sun . . ." Such was the contemporary opinion of Cajal, one of the most striking personalities in the modern world of science.

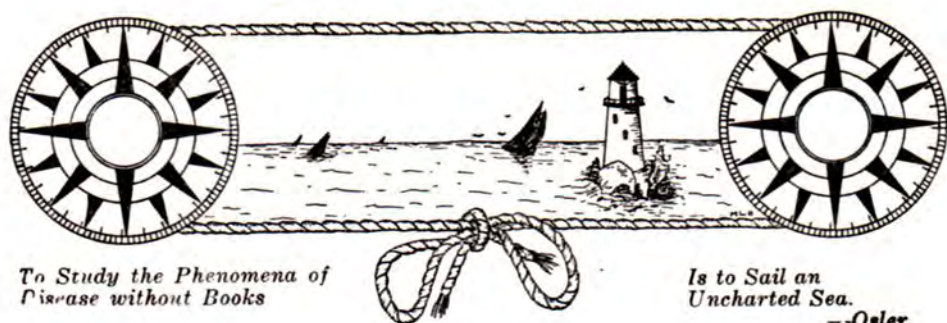
This is the simple, humble story of the founder of the famous Spanish school of histology; the story of Cajal, the boy, with his turbulent school career and his almost uncanny ability with the sling to crack a "pate" at one hundred paces; the story of Cajal, the scientist, with his tenacity and determination which resulted in his winning of the 1906 Nobel Prize and Helmholt's medal; the story of Cajal, the philosopher and observer, with his astute ability to pierce the thin veneer of society and view the world of people with the same logical eyes that viewed the tissues under his microscope.

As a tribute to Cajal's scientific worth it has been said that he it was who converted the concept of the nervous system from the state of a hopelessly tangled jungle to one of carefully planned paths and gardens. He showed that the nervous system was composed of individual units (neurones) and not of a tangled, meaningless Reticulum. He discerned the meaning of the optic chiasma, the single direction of conduction along a nerve fibre, and almost all other concepts which are now basic.

It was Cajal's ambition to raise his beloved Spain out of the state of intellectual degradation into which she had fallen. He was a man of vision, and of faith—faith in Spain, the Spaniard, and above all in the dignity of man.

For every student of neurology and histology, this book is a must—for every student of medicine and of human personality, a book of absorbing interest.

—R. PRINCE, '50.



To Study the Phenomena of
Disease without Books

Is to Sail an
Uncharted Sea.
-Osler.

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April 13, 1948.



EXPERIENCES WITH SYMPATHECTOMY IN THE MANAGEMENT OF PERIPHERAL VASCULAR AND OTHER DISORDERS

DR. R. H. SMITHWICK

Afferent fibres from the abdominal viscera are carried in both the sympathetic and para-sympathetic systems. Pain fibres, however, are confined to the sympathetic distribution of the autonomic nervous system. These pain-carrying fibres run without synapses through the outlying ganglion to the sympathetic chain, then reach the spinal cord by the posterior root, synapse and finally ascend to the thalamus. The section of sympathetic fibres has been used in the treatment of intractable abdominal pain.

Experimentally, if a balloon is placed in the intestine and inflated, intense pain not associated with muscle rigidity is referred to the skin over the abdomen. The area of reference is larger and the pain more intense the greater the tension created by inflating the balloon.

After unilateral Splanchnicectomy pain in this experiment is felt only on the unoperated side and the threshold is higher. Thus for certain types of pain, for instance that due to calcification of the pancreas, unilateral section is sufficient even though the viscus is bilaterally innervated.

As an example, Dr. Smithwick cited a patient with calcification of the pan-

creas and mid-line pain. Being diabetic and hypertensive, he was not a good candidate for extensive pancreatic surgery. Three years ago unilateral splanchnicectomy was performed. The patient has been free from pain since that time. This type of operation is also indicated in patients who experience no relief of pain after gall bladder surgery.

Another use of sympathectomy is in the treatment of long-standing intractable anginal pain. Surgery in these cases carries no greater risk than paravertebral alcohol block and avoids such unpleasant complications as intercostal neuritis, which sometimes follows the alcohol injection. In order to eliminate all pain fibres, segments one to five of the sympathetic chain and the inferior cervical ganglion are removed. Section of segments higher than T₁ should be avoided, otherwise a Horner's Syndrome will be the resulting complication.

Motor disorders of the heart have likewise been attacked by sympathectomy. The physiological rationale for this is as follows: responding to exercise and emotion, the heart speeds up as a result of two mechanisms:

1. Inhibition of vagal tone caused by reflexes originating in the right side of the heart.
2. Acceleration by super-imposed sympathetic stimulation.

Sympathectomy eliminates the second mechanism, and thus disabling tachy-

*These are abstracts of papers given at the seventh semi-annual lectureship, April 7-9, 1948.

cardia provoked by slight exertion or minor emotions can be alleviated.

In hypertensives the accelerator response, as well as the resulting pulse rate, must be considered when surgical steps are contemplated for hypertension. When this response is exaggerated, it is well to combine resection of the sympathetic supply to the heart with lumbo-dorsal sympathectomy. If this is not done, patients may suffer post-operatively from vertigo and syncope. Sympathectomy in these motor disorders includes fibres from T₂ to T₅.

Another group of disorders benefited by sympathectomy is peripheral vascular disease. To denervate the arm, the second and third intercostal nerves are resected and the sympathetic chain cut below the third ganglion. The decentralized sympathetic trunk is put in a silk capsule and sutured to muscle to prevent regeneration. For the lower extremities, the sympathetic outflow from L₂ to L₄ has to be removed to denervate the parts distal to the knee, and L₁ to L₄ to denervate the whole leg. Peripheral conditions helped by sympathectomy include Raynaud's disease, scleroderma, hyperhidrosis and Buerger's disease. In the latter condition, the collateral circulation has to be adequate if sympathectomy is to be helpful. Sympathectomy in these cases should be done early before terminal gangrene sets in. Even after gangrenous changes have occurred, sympathectomy may make it possible to perform only minor surgery instead of radical amputations. Careful selection of cases for sympathectomy is of special importance when dealing with peripheral vascular disorders. The more the patient's trouble is due to vasospasm as opposed to occlusion, the more he will benefit by sympathectomy. If he has marked arterio-sclerosis, absent popliteal pulse, poor collateral circulation, and "rest pain", sympathectomy will probably be of no use. The degree of vasospasm can be assessed by various tests. These may consist in blocking the sympathetic nerve supply by—

(a) Paravertebral block (Novocaine),

(b) spinal anaesthesia, (c) a blocking drug such as Etamon Chloride.

Another test consists in measuring changes in skin temperatures with changes of environmental temperatures. Similar information can be obtained by the Landis test. The latter test consists of a study of the amount of resulting dilatation of the vessels of the lower extremities when the arms have been immersed in warm water for a certain period. Should the popliteal pulse be absent, the adequacy of the collateral circulation in the lower extremities must be assessed by observing the colour changes in different positions of the limbs. The longer the extremity takes to blanch on elevation and the shorter to become flushed on lowering, the better the prognosis. The collateral circulation is excellent if flushing occurs within twenty seconds, and very poor if it takes more than forty.

—PAUL SCHNELLER, '49.

THE EFFECT OF VARIOUS SURGICAL PROCEDURES ON GASTRIC SECRETION

DR. R. H. SMITHWICK

This lecture deals with some preliminary observations of patients with peptic ulcer. It is hoped to develop a procedure of choice for individual patients with refractory ulcer.

A review of the literature reveals that the acid-peptic factor is the important one in the production of an ulcer. Mann and Williamson, by diverting the secretions which neutralize gastric juice as it leaves the stomach to another part of the intestine, were able to demonstrate the production of an ulcer in almost 100% of their animals. Wagensteen, by causing an increased secretion with repeated doses of histamine, produced ulcers in a high percentage of his animals. Clinical evidence shows that procedures producing the greatest reduction of gastric acidity have the greatest tendency to prevent recurrences.

We studied the problem with particular reference to the effect of various operations on the gastric secretory mechanism. Acidity was judged by comparison with complete achlorhydria rather than with variable previous levels. The treatment can be judged finally only after a follow-up of a series for ten to fifteen years. In the interim a study of the effect of treatment on gastric acidity will enable a decision as to the procedure of choice for any given case.

The purpose of surgery is the prevention of recurrent ulceration. The most effective procedure, protecting animals from the ulcers produced by repeated injections of histamine, has been resection of the lower three-quarters of the stomach with gastro-jejunostomy. This results in complete achlorhydria in most cases. Wagensteen found the rate of recurrence after such a procedure to be very low, about one in four hundred.

The available surgical procedures are: 1, gastric resection; 2, vagectomy; 3, a combination of gastric resection and vagectomy; 4, other operations on the stomach. Denervation of the parasympathetic supply to the stomach fails because it relieves only the neurogenic secretory mechanism. Difficulties arise due to the fact that the whole area must be denervated. It would seem important to obtain data on both the neurogenic and chemical gastric secretion in any given case. Vagectomy might be effective in isolated cases of high neurogenic secretion.

The operations of pyloroplasty and gastroenterostomy have been used, but later were discarded as ineffective.

In order to evaluate various procedures we investigate the free acid, total acid, volume and pH of the secretion, prior to the operation and at intervals thereafter. The neurogenic activity is studied by obtaining the total night secretion in a series of three-to-four-hour specimens. The basal fasting morning secretion is charted on two occasions. The maximal potentiality of secretion by stimulation of the vagus is deter-

mined by means of the insulin test. The chemical secretion is studied by giving 80 c.c.s of peptonized beef broth, leaving it in the stomach for twenty minutes and then following the secretion for one hour. The histamine test is also used to observe chemical secretion. In this manner the pattern and potentialities of secretion can be ascertained. Thus one can classify the cases and attempt to choose the best procedure for treatment in each case.

The first method of treatment was resection of the vagus. One case, after operation, showed no response to insulin, free acid only occasionally, no response to broth but a slight one to histamine. The result was very good. A patient with a high night secretion and a high insulin response still had a high free acid with a pH below 4.5 after treatment. A study of the series revealed the following residual symptoms after resection of the vagus: Gastric stasis, 1.8%; diarrhoea, 7.5%; ulcer pain, 4%; bleeding ulcer, 1%; persistent ulcer, 1%; perforation, about 1%.

Gastric resection was then studied, considering the question whether a radical one was necessary or whether the operation could be adjusted to the individual. A case of refractory duodenal ulcer with low free acid, a low response to insulin but a high histamine test, was treated with a 50% gastric resection. This resulted in complete achlorhydria to all of the tests. Another case with a marked response to all the tests still had a high acidity after a two-thirds resection. In a case with very marked responses to all of the tests, the procedure resulted in a condition in which free acid appeared only in response to broth and histamine tests. One of the patients treated in this way returned with a jejunal ulcer after a three-quarter resection. The residual signs after gastric resection varied with the gastric secretions and the size of the resection and were as follows: Weight loss, average 17 pounds, 75%; specified food intolerance, 13%; weakness, 8%; stomach symptoms, 8%; dumping syndrome, 7%; jejunal ulcer, 3%; per-

sistent symptoms, 2%; anaemia, .7%.

Next, gastric resection plus resection of the vagus was studied. In a case of stomach ulcer the acidity became very low, with pH above 4.5. One of the accepted indications for vagus resection is recurrent ulceration following gastric resection. A patient with a previous gastro-enterostomy and a partial vagus resection developed a gastric ulcer despite a low pH. After a one-half gastric resection and a vagus resection, tests showed a complete achlorhydria. Another case of duodenal ulcer and gastric ulcer, with low basal levels but very marked response to insulin and histamine, had no free acid except on a histamine test after a similar procedure. A patient with obstructed duodenal ulcer and a very high free acid had complete achlorhydria, except for a minimal response to histamine, following a partial gastric resection and a vagus resection. Early results of the studies carried out on this series of cases would indicate that there are few untoward results. The patients do well, eat well, and gain in weight.

No significant change was noted in duodenal ulcer cases who had splanchnicotomy for hypertension. The basal secretions were lower and there was a delayed response to the insulin test.

In experimental animals ulcers cannot be produced with histamine following vagus resection and splanchnicotomy. Clinically, however, patients continue to secrete acid following this procedure.

Although the peptic ulcer problem is unsettled, a careful standard method of study may result in a knowledge of the procedure of choice in a given case. In severe refractory cases resection of the vagus plus a reasonable gastric resection seemed to give best results. It will be possible, with experience, to place all cases in definite categories for which one of the various procedures will produce the best results.

—C. GORDON CAMPBELL, '49.
WILLIAM J. DAVIS, '49.

THE FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM

DR. O. G. EDHOLM

Cannon summed up these functions in the phrase "the maintenance of homeostasis", i.e. the maintaining of a constant internal environment. The autonomic nervous system supplies viscera, secretory glands, smooth muscle in general and controls the cardiovascular system and body temperature.

It has been proven that the coronary arteries and the blood vessels of erectile tissue and those of the salivary glands receive both sympathetic and parasympathetic fibres. All other blood vessels are supplied, apparently exclusively, by the sympathetic system, e.g. the blood vessels of the skin and of the muscles of the limb receive only vasoconstrictor impulses and it is inhibition of these impulses which enables vasodilatation to take place.

The Landis Test measures the temperature of the hands after the feet have been placed in water at 45°C, or vice versa, the temperature of the feet with the hands in water. It reveals: (1) whether the autonomic nerve supply to the vessels of the limbs is functioning (and thus, for example, whether a sympathectomy performed is complete in this respect); (2) what is the capacity for dilatation of the blood vessels, i.e. the state of the blood vessels.

After sympathectomy, it has been found that the blood vessels in the extremities dilate to their fullest extent. Muscle blood vessels also dilate, but not to the fullest possible extent, signifying that the vasomotor nerve supply to skin vessels is, normally, greater than that to muscle vessels. After three weeks, the tone of the blood vessels to muscle has reached the preoperative level, while only part of their former tone is regained by the skin vessels. Tone is regained because the blood vessels become sensitized to a substance in the blood, i.e. to circulating adrenalin.

If the preganglionic fibre of the sympathetic nerve is sectioned, the ganglion

cell will become sensitized. If the post-ganglionic fibre is cut, the ganglion cell degenerates, and the ending in the viscus becomes sensitized. Since the sensitization is much greater at the viscus, the operative procedure of choice in a sympathectomy is a preganglionectomy.

DON MARSHAL, '49.

THE AUTONOMIC SYSTEM AND ITS RELATION TO CLINICAL DISORDERS

DR. G. E. HOBBS

The autonomic nervous system is the framework which makes emotion and feeling a reality as an influence on the individual.

The control of the system functions at various levels. The highest level is in the cortex, where most centres appear to be in the frontal lobes. Both the sympathetic and parasympathetic systems are extensively represented. Their areas overlap and are associated with the area concerned with voluntary movements.

Functions at this level comprise:

- (a) Minor alterations which must take place with simple movements such as those of a hand.
- (b) Changes as a result of thought processes.

Below the cortex is the hypothalamus, which is concerned with heat regulation and blood pressure control.

In 1928 Bard, by section experiments, showed that when the base of the brain was sectioned the blood pressure control was lost.

In 1932 Cushing, during an operation, either stimulated or damaged the hypothalamus and noted that it affected the stomach.

The lowest level is the spinal cord, which carries out simple reflex adjustments. At one time it was thought that

the sympathetic chain had a cephalic connection, but this is not so.

Sweat and Heart Rates

The degree of sweating and the heart rate of normal individuals were recorded while they were doing mental arithmetic or when a door was suddenly slammed. Some individuals showed a marked acceleration of the heart rate, with little or no increase in sweat. Others showed just the reverse. Still others showed both increased sweating and accelerated heart rate.

In anxiety neurosis the symptoms are due to disorders of the autonomic system, but whether or not these disorders may cause actual lesions in the organs controlled by the autonomic is still a highly controversial subject.

Gastric Ulcer

Gastric ulcers may occur in any type of person and under almost any conditions, but emotional strains seem to be a definite factor. Exacerbations are nearly always associated with certain conditions in the environment.

Studies of the gastric mucosa of man revealed a pale mucosa and hypomotility during fear and a hyperaemic mucosa and hypermotility during anger.

Hypertension: Fluctuation in Blood Pressure

White, et al., made a statistical analysis of 22,741 United States Army officers to determine the prognostic significance of transient hypertension and transient tachycardia. Their results showed that the group with transient hypertension showed a greater incidence of later sustained hypertension than did the control group. The group with transient tachycardia showed rates for later sustained hypertension similar to the group with transient hypertension. When both transient tachycardia and transient hypertension were present, the incidence of later sustained hypertension was more than twice as great as when either condition was present alone.

In conclusion, it is emphasized again that the autonomic is not just a peri-

pheral system and that its possible relations to various clinical disorders should always be kept in mind.

—ROBERT H. ELDER, '49.

MEDICAL ASPECTS OF ESSENTIAL HYPERTENSION

DR. E. BARTRAM

It is emphasized that, in the medical management of essential hypertension, the physician should know his patient intrinsically. Only in this way can the patient's conflicts and problems be fully comprehended.

The course of essential hypertension can be divided into three stages, namely: (a) the prehypertensive stage, 20-35 years of age; (b) the fluctuating stage, 35-45 years of age; (c) the fixed stage, from 45 years of age on. Within the fixed stage one finds the clinical features of the disease, namely, cardiac hypertrophy and arteriosclerosis. Sixty per cent of essential hypertensives end with angina pectoris, cardiac failure, or coronary thrombosis. Twenty per cent terminate in cerebral thrombosis, haemorrhage, and encephalopathy. Ten per cent terminate with renal complications.

In studying the hypertensive patient one must note particularly a family history of hypertension or its manifestations; this is especially significant when occurring on both sides of the family. Also to be noted is the presence of any disturbing emotional factors. These emotional factors have a significant rôle, especially in the prehypertensive stage. One worker has likened the emotions of the prehypertensive to "millions of Goldblatt clamps" working on renal arterioles.

Treatment: The treatment of the manifestations of the fixed stage is actually the treatment of the complications of the disease. The time to treat the disease itself is in the first two stages and this can only be accomplished by knowing the patient well. The patient is usually energetic, ambitious, forceful,

and dynamic. Here the treatment resolves itself into helping relieve conflicts and impressing the patient with endeavouring to find inner peace and satisfy himself with a less strenuous life.

An estimation of the damage caused by the hypertension can be ascertained by examination of:

(1) The vessels of the ocular fundus—this gives some idea of the condition of the vessels elsewhere in the body.

(2) The heart—heart size is of special significance.

(3) Kidney—its ability to concentrate and dilute is especially important.

(4) Diastolic pressure also gives some idea of peripheral vessel condition. A diastolic pressure of over 140 is of grave omen.

Drugs

(1) Sedatives are very valuable in treatment, e.g. phenobarbital and chloral hydrate.

(2) Potassium thiocyanate is of value in selected cases but its effective therapeutic level is dangerously near the toxic level. It is of use, however, in headaches of hypertensive origin. It is contraindicated in the presence of renal complications or of cerebral sclerosis.

(3) Digitalis and salyrgan are of great value in left ventricular failure and cardiac asthma.

(4) Bleeding, in the form of blood donations, every three to four months may be of definite value in relief of symptoms of cerebral and cardiac origin particularly.

(5) Lumbar puncture is of minimal value in relief of headache.

—J. EDWARD MULLENS, '49.

THE ROLE OF THE KIDNEY IN HYPERTENSION

DR. E. D. BUSBY

The kidney's role in hypertension has never been fully understood. It has been

known for long that high blood pressure and diseased kidneys often are associated but it is still a mystery whether the kidney trouble causes the hypertension, or vice versa.

Although cerebral and cardiac accidents are diagnosed as the immediate cause of death in patients with malignant hypertension four times as often as renal failure, it has been shown at autopsy that the most frequent site of vascular disease is the kidney. (The spleen only excepted.)

Investigating the relation of the kidney to hypertension in experimental animals, Goldblatt found that although systemic hypertension could be created by clamping off the renal arteries, there were no changes in the glomeruli and arterioles in the ischemic kidney(s), i.e. the kidney did not show the usual deterioration present in hypertension in man due to natural causes. However, if the ureter of one kidney and the renal artery of the other are clamped, the latter kidney shows no changes but the non-ischemic kidney is found to have been affected. These experiments seem to show that, to produce the kidney changes seen in malignant hypertension in man, there must be hypertension in the renal artery itself.

Is the kidney capable of producing general hypertension (which will affect its arteries, too)? It has been suggested that an ischemic kidney may produce a chemical vasoconstrictor substance, "renin", which, together with an activator, "angiotonin", is responsible for the development of hypertension. The following etiological theories of interference with the renal blood supply causing an ischemia of the kidney have been offered:

1. Torsion of the renal pedicle of a floating kidney.
2. Mechanical compression at the kidney hilum.
3. Vicious circle of hypertension of unknown cause, perhaps from an over-active sympathetic system producing a renal vascular lesion which further

aggravates the hypertension, i.e. the hypertension antedates the kidney changes and the latter are only contributing factors. (Smithwick.)

The conclusion reached by White and Smithwick: The cause of altered renal blood flow is not clear.

In regard to therapy to relieve hypertension, several operations have been performed in this city to remove one kidney, these being followed by a remarkable drop in the blood pressure in each case. However, it should be emphasized that hypertension from unilateral kidney disease is not common. In a survey of 1,684 kidney operations at the Mayo Clinic, hypertension was found in the following conditions:

1. Tuberculosis	8%
2. Atrophic Pyelonephritis	50%
3. Hydronephrosis	14%
4. Renal Calculi—	
(a) Septic	22.5%
(b) Aseptic	5%
5. Adenocarcinoma	27%

In Atrophic Pyelonephritis and Hydro-nephrosis, much atrophy and sclerosis is found and it is in these cases and in Congenital Renal Hypoplasia, the "Goldblatt kidney" (which is very subject to infection, this hastening the destruction), that unilateral nephrectomy may give dramatic results in bringing the blood pressure back to normal. This is especially true if the patient is young, the opposite kidney clinically normal, and the disease is of short duration.

Although opinions of the role of the kidney in hypertension vary widely, it would seem advisable to heed the statement of Reed Nesbit: "Routine urologic studies of all hypertensives are desirable." —MEDS '49. —NORMA DEAN

HYPERTENSION AND CORONARY THROMBOSIS

DR. J. C. PATERSON

There is much controversy regarding the etiology of coronary thrombosis, but

all pathologists are agreed on two points:

- (1) That while stagnation of blood or changes in its chemical or physical properties may cause the formation of thrombi in veins, these factors are not sufficient to initiate thrombus formation in arteries. A definite point of injury of the arterial wall is necessary before an arterial thrombus may form.
- (2) That coronary thrombosis in approximately 95% of cases occurs at a point of pre-existing atherosclerosis.

Accepting, then, the statement that a lesion within an atherosclerotic plaque is the immediate cause of coronary artery thrombosis, the theories of the mechanisms whereby thromboplastic material might be liberated may be now reviewed:

- (1) Bacteraemia and establishment of an infective focus (Boyd).
- (2) Necrosis and ulceration of superficial layer of plaque (Leary).
- (3) Rupture of capillaries in the plaque with the formation of a haematoma.

This last point may be now elaborated. Old atherosclerotic plaques become well vascularized and the speaker has been able to show by careful serial sections that these capillaries open into the lumen of the artery and are not derived from the vasa vasorum. Rupture of such capillaries to produce intimal haemorrhages would be favoured by the following factors:

- (1) The softness of the atheromatous material about the capillaries allowing them to bulge and rupture. (These haemorrhages occur in the soft plaques found in middle and early old age, not in the firmer plaques of old age.)
- (2) A weakening of the capillary walls by toxæmias, low-grade infections, low Vitamin C intake, and other such factors.
- (3) The fact that these small capillaries are in direct communication with

large arteries in which the pressure is high.

This question of high intracapillary pressure is the point at issue. The speaker, in his study of a rather large group of cases at autopsy, has been able to show that intimal haemorrhages could be found at the point of attachment of coronary thrombosis in 90% of individuals who had *persistent* hypertension and marked coronary sclerosis. (Similar intimal haemorrhages were found in only 40% of non-hypertensive cases.)

The speaker believes that intimal haemorrhages might similarly be caused by *transient* elevations in blood pressure such as follow physical exercise and emotional stress. It is therefore suggested that individuals suspected of having a significant degree of coronary sclerosis be advised to avoid incidents which might result in transient but high elevations of blood pressure.

—NATE HELLER, '49.

THE CONTROL OF PERIPHERAL BLOOD FLOW

DR. A. C. BURTON

Any theories of hypertension must satisfy the fundamental physical laws of haemodynamics and therefore it is essential to understand the part played by peripheral resistance in the maintenance of blood pressure. Peripheral resistance can be calculated from the formula:

$$\text{Total Peripheral Resistance} = \frac{\text{Pressure Difference}}{\text{Cardiac Output}}$$

Since the cardiac output is normal both in normal people and in hypertensives but the pressure difference is much greater in hypertensives, then the total peripheral resistance must also be proportionately greater in hypertensives. And since blood viscosity is essentially normal in hypertensives, then the increased peripheral resistance can only result from narrowing of the vessels.

This resistance has been shown to lie largely in the arterioles and only slightly in the capillaries. In Labile Hypertension the resistance is higher during vasoconstriction; in Fixed Hypertension the resistance is higher during both vasoconstriction and vasodilatation.

With regard to the depressor reflexes originating in the Aortic Arch and Carotid Sinus, it is suggested that they are apparently "not on the job" in hypertensives even though they can still be made to operate experimentally by external physical pressure.

The main ideas now current as to the cause of the narrowed vessels in hypertension are:

- (1) Galdblatt's theory that pressor substances, notably Renin, originate in the ischemic kidney.
- (2) Smithwick's theory that there is a generalized vasoconstriction due to a hypersympathetic effect or due to exaggerated response of vessels to normal sympathetic activity.

Each of these theories by itself leaves much to be explained and a new concept is now offered that there may be certain humeral substances which, while not pressor in themselves, somehow operate by augmenting and potentiating sympathetic responses. For instance there may exist congenital humeral factors which will potentiate sympathetic responses.

To assume now the guise of a prosecuting attorney, a brief may be offered of the circumstantial evidence against the Adrenal Cortex as one example of a possible source of such substance. It may take fifteen years of investigation to finally exonerate or incriminate this suspect or others, as, for example, the liver. However, there now exist the following scraps of evidence against the Adrenal Cortex:

- (1) In Addison's Disease there is a low blood pressure.
- (2) The hormone Desoxycorticosterone can produce the picture of Labile

Hypertension in normal subjects.

- (3) Adrenalectomized animals lose all pressor responses, including the response to Renin.
- (4) Low Sodium-High Potassium diets are used therapeutically by some in hypertension and the Adrenal Cortex is known to be involved in Sodium-Potassium metabolism.
- (5) There is some pathological evidence of Adrenal Cortical hyperplasia in hypertension.
- (6) Adenomas of the Adrenal Medulla are associated with paroxysmal hypertension and there are probably more connections between cortical and medullary activity than were once thought to exist.
- (7) There is an associated disappearance of Cholesterol from the Adrenal Cortex when the latter is hyperactive and Cholesterol is known to be associated with arteriosclerosis.
- (8) Stress and trauma, frequently associated with hypertension, are known to be also associated with an increase in corticotrophic hormones from the Anterior Pituitary Gland.

All this evidence seems to warrant further research on the role of the Adrenal Cortex in the production of hypertension.

—ROBERT A. HAGGAR, '50,
JOHN S. W. ALDIS, '50.

THE MEDICAL MANAGEMENT OF PERIPHERAL VASCULAR DISEASE

DR. F. S. BRIEN

Arteries, veins, and small vessels all participate in various types of peripheral vascular disease. Functional-spastic changes may be imposed on varying degrees of obliterative phenomena but pure functional changes are rarely seen. The blood vessels are under humeral and nervous control, the latter consisting of vasoconstrictor and possibly vasodilator fibres.

The signs and symptoms of peripheral vascular disease may be varied but the chief ones are as follows: Discoloration, coldness of the part, paraesthesia, perhaps loss of function, and pain. Pain may be continuous or come only after exercise. Rest pain, however, has an unfavourable prognosis.

The element of spasm must be assessed and for this purpose the reactive hyperaemia test, the limb immersion test, local or general nerve block tests and sympathetic block by such agents as tetraethyl ammonium chloride may be used satisfactorily. A constant temperature and humidity room with a temperature of 68-70° F. may be desirable.

Treatment

General supportive measures and proper care to the feet are important. If infection, ulceration, ischaemic rest pain, arterial embolism, or thrombosis occur, patients must be kept in bed. Heat is employed on the unaffected limb in cases of occlusion, since it produces reflex vasodilation—however, heat is contraindicated in the affected limb, since it increases tissue metabolism. The role of tobacco and its use is controversial.

Numerous chemical agents such as alcohol, asperin, papaverine, adrenaline, benzadrine and neosynephrine have been employed. Paravertebral block has been used satisfactorily in some cases. Postural exercises and intermittent venous occlusion may be of some value. The use of heparin and dicoumerol therapy prevents propagation of thrombi and seems to give excellent results. Tetra-ethyl ammonium chloride and bromide has been used but these substances do not always produce results and are not without danger.

In 88% of cases of embolic occlusion the source of embolus was the heart and usually in one of three main conditions: cardiac infarction, and mural thrombus, auricular fibrillation and subacute bacterial endocarditis.

The treatment of arterial embolism is an emergency, and careful management

in hospital is necessary and of course depends upon the site of occlusion.

—WILLIAM N. SIMS, '49.

CARDIAC CATHETERIZATION

DR. J. A. LEWIS

Cardiac catheterization should no longer be considered a surgical procedure, but an aid in the medical diagnosis of congenital heart lesions. All the chambers of the heart, the pulmonary arteries and veins, the aorta, and even the hepatic and renal arteries, have been entered with a radio-opaque catheter introduced from the cephalic vein on the left side. To prevent coagulation, heparin in saline is introduced through the catheter.

Samples of blood are collected under oil from the various heart chambers and great vessels, and a gas analysis, usually blood oxygen, is done on each sample. The blood pressure is also measured as the catheter enters the various heart chambers. Then, by simple calculations and comparison of these results with those considered to be normal, the operator can recognize and diagnose such congenital abnormalities of the cardiovascular system as coarctation of the aorta, patent foramen ovale, interventricular septal defects, and patent ductus arteriosus.

The radio-opaque catheter can be visualized both by means of the X-ray flat film and by means of the fluoroscope. The blood picture and blood oxygen tension, however, determine the exact position of the tip of the catheter at any given time.

One most interesting but yet unexplained observation is the presence of arterial blood in the peripheral parts of the pulmonary artery.

—DAVID SIM, '49.

ABDOMINAL AORTIC ANEURYSMS

DR. L. D. WILCOX

In this country abdominal aortic

aneurysms due to arteriosclerosis are twenty times as common as those due to syphilis; increased age of patients is making this condition more common. The characteristics of the arteriosclerotic aneurysm are: (1) location in the lower aorta, usually distal to the renal arteries; (2) elongation and tortuosity of the aorta, with bulging more often to the left than to the right; (3) no erosion of the spine at any time. The syphilitic aneurysm, on the other hand, is located higher up in the aorta; it is more fixed than the arteriosclerotic type; it tends to erode the spine.

Symptoms of Abdominal Aortic Aneurysm

1. Mass noticed by the patient to be pulsating.
2. Pain, dull, sharp, or tearing, in the lumbar region, radiating at times to the thighs, hips, groin, testes. Bleeding may produce intense, intermittent pain.

Symptoms of Perforation

1. Changing pain, especially when radiating to lower abdomen, indicates perforation.
2. Pallor, faintness, thirst, and sweating occur with each spurt.
3. Nausea and vomiting indicate spreading of haemorrhage into the mesentery.
4. Colon, stomach and kidney symptoms may also be present.
5. Death does not occur for two to four days. (Perforation of a thoracic aneurysm produces sudden death.)

Signs of Abdominal Aortic Aneurysm

1. Tumour, two to six inches in diameter, felt centrally to the right or left of the midline, often mobile and showing expansile pulsation.
2. No murmur or thrill is present.

Signs of Perforation

1. Abdominal tenderness and rigidity result from the formation of a dissect-

ing hematoma, especially if the dissection involves the root of the mesentery.

2. Massive gut bleeding may be present if the perforation is into the duodenum or other part of the G.-I. tract.
3. Retroperitoneal bulge into the loin, usually on the left side. (Perforation usually occurs posteriorly.)
4. Mass in inguinal canal, usually the left.
5. Bruised area over the flank.
6. Quiet abdomen usually.
7. Shock. Fall of blood pressure with retroperitoneal bleeding. Pulse rate may be high or low.

Special Tests

1. X-ray of abdomen will show calcification of the sac of the aneurysm if this is present, and will reveal any associated changes, as displacement, of the G.-I. tract or kidneys.
2. With perforation, a leucocyte count shows an increase to 10,000-20,000. Sedimentation rate is also increased and haemoglobin decreased.

Differential Diagnosis

1. G.-I. and kidney lesions with similar findings.
2. A leaking aneurysm with low back pain may resemble a neoplasm of the spine.

Prognosis

Life expectancy is one of months usually, since 65% of all cases perforate.

Review of eight cases and presentation of one unusual case, a patient with a diagnosed abdominal aneurysm since 1939.

Treatment (by Dr. R. H. Smithwick)

1. Procedures which have been tried:
 - (a) In the 1870's a tourniquet was applied to the abdomen above the aneurysm and left in place for a day or two to thrombose the cavity.

- (b) Proximal ligation with ordinary sutures.
 - (c) Several ligatures of cotton tape or fascia lata.
 - (d) Wrapping of vessel with cellophane, with gradual occlusion by fibroblastic reaction.
2. The answer perhaps may be denervation by sympathectomy of the vascular bed distal to a ligation of the vessel to aid in the collateral circulation.
 3. Wiring of the aneurysm, which may be combined with a current to hasten coagulation, and is usually done in three stages ten days apart. (Dr. Smithwick himself prefers wiring alone, i.e. without electrocoagulation, and performs the operation, in one stage.) —EUNICE OESTREICHER.

Treatment is often regarded empirically rather than sensibly.

Aetiology varies from heredity and occupation to trauma.

The tests done should be: Trendelenburg test, Perthes test, cough test, compression bandage test, comparative tourniquet test and venograms. These tests check for reversal of flow, incompetent valves, patency of deep veins, inadequate valves of communicating veins and competent arterial circulation.

Complications mostly met are edema, ulceration, haemorrhage, dermatitis and thrombophlebitis.

Treatment is either preventative, conservative (i.e. compression bandaging, rest, minimal standing, etc.), ligation, injection, excision, combined ligation and injection, palliation and management of complications. In a series of 288 cases from 1941 to 1948, 204 were females and 84 were males. Early ambulation in operations on superficial phlebitis in varicose veins was strongly stressed.

—ARMAND DI FRANCESCO, '49.

THE MANAGEMENT OF VARICOSE VEINS

DR. A. J. GRACE

Varix is a common disease and progressive, often leading to complications.



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on by the nurses." From "*Report on the Clinical Use of Bone Meal*" by E. M. Martin, M.D., in the *Canadian Medical Association Journal*, Vol. 50.

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