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LIVER FUNCTION*

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The functions of the liver are many. The liver has to do with carbohydrate metabolism and fat metabolism; it is concerned with the formation of plasma proteins and many of the elements necessary for the clotting of the blood; by virtue of its Kupffer cells, it takes on all of the functions of the reticulo-endothelial system; it has to do with the metabolism of hormones, the metabolism of vitamins and the metabolism of cholesterol; it is the site of formation of a number of enzymes and also, possibly, of many antibodies; it has to do with bile formation and the metabolism of both bile salts and bile pigments; in addition, it is an organ of excretion and an organ of detoxication. The liver has been called, with some justification, the "chemical factory of the body".

The biochemist is frequently questioned as to what is the "best" test of liver function. The "best" test of liver function depends, of course, on what function of the liver it is wished to test. The liver has many functions and there is, presumably, a "best" test for each of these. By "best," however, is usually meant the test, or tests, which is of the most value (1) in the differential diagnosis of patients with liver disease and (2) in following the progress of patients with established liver disease. In this paper I propose to discuss some of the functions of the liver, confining myself to those functions that have been used in liver function tests. Some of these tests of liver function are of help to the clinician; some, I am afraid, are of very little value.

Many liver function tests have been employed in the past. What might be called the classical approach to the problem has been summarised in the very comprehensive paper of Soffer (1935). Of recent years, however, much has been learned of the pathology of liver disease, and of the progress of the liver throughout the course of an illness, by a study of fresh specimens, obtained from the liver by the method of punch biopsy. For a description of this technique the reader is referred to the reports of Iversen and Roholm (1939) and Sherlock (1945). Such work

*Based on a lecture given at the 8th Alumni Lectureship, U.W.O., October 1948.
has been responsible for a re-evaluation of many of the hitherto popular tests of liver function. Sherlock (1946) compared the findings on liver biopsy with the results of a number of liver function tests. In much of what follows I am quoting heavily from this excellent paper. Other work on the comparison of liver function tests with biopsy findings has been published by Hoffbauer, Evans & Watson (1945) and Popper and Franklin (1948). In the following paragraphs an attempt will be made to assess the value of each test of liver function in differentiating the parenchymatous liver damage of 'medical' jaundice, such as is found in hepatitis or cirrhosis, from the 'surgical' jaundice of extrahepatic biliary obstruction. In many instances, the value of the test in gauging the progress of patients with liver disease will also be discussed.

(1) Metabolism of Bile Pigments

The metabolism of bile pigments is represented schematically in Figure 1. Bilirubin is formed by the breakdown of haemoglobin from red blood cells. This takes place in the reticulo-endothelial system, and may take place in the Kupffer cells of the liver itself. Much of the bilirubin, formed in reticulo-endothelial tissue outside the liver, reaches the liver by way of the blood stream. Under normal circumstances, none of this bilirubin is excreted by the kidney but, if the concentration of bilirubin in the blood is unduly high, some bilirubin will appear in the urine. Usually the bilirubin of the blood passes to the liver, where it is excreted with the bile into the gastro-intestinal tract. Here the bilirubin is reduced to urobilinogen by bacterial action and the urobilinogen may subse-
quenty be oxidized to urobilin. These bile pigments appear in the faeces where they are sometimes referred to as stercobilinogen and stercobilin respectively. These, and similar pigments, are responsible for the characteristic colour of the stools. Some of the urobilinogen in the gut is absorbed into the portal vein, whence it is carried to the liver. Most of this urobilinogen is abstracted from the portal blood by the liver, oxidised back to bilirubin, and re-excreted into the gut by way of the bile. Thus there is a local circulation of bile pigment, from liver to gut by way of biliary passages, and from gut to liver by way of the portal system. When the liver is diseased the urobilinogen is not removed from the portal vein. It passes the liver and so reaches the systemic circulation, from which it is removed by the kidney. During its passage down the renal tract, and in urine after voiding, this urobilinogen may be oxidised to urobilin.

From the viewpoint of hepatic function, four measures of bile pigment metabolism are desirable: (a) the concentration of bilirubin in the serum, (b) the concentration of bilirubin in the urine, (c) the concentration of urobilinogen (plus urobilin) in the urine, and (d) the concentration of bile pigments in the faeces.

(a) **Bilirubin in Serum.** The serum bilirubin can be conveniently measured by the method of Malloy and Evelyn (1937). In patients with jaundice the serum bilirubin concentration is usually greater than 2-2.5 mg./100 ml. In jaundice due to excessive red cell destruction the bilirubin concentration is not greatly increased, whereas in jaundice due to biliary obstruction the concentration is high, frequently being greater than 15 mg./100 ml. In hepatitis the serum bilirubin concentration is intermediate in value. In patients with hepatitis the degree of bilirubinaemia is a good index of the degree of liver damage observed histologically, and the serum bilirubin is also a fair measure of the progress of the disease. In obstructive jaundice the serum bilirubin gives some indication of the duration of the obstruction.

In the past, much emphasis has been put on the Van den Bergh test. An *indirect positive* reading was supposed to mean that the bilirubin in the plasma had not passed through the liver and that the jaundice was due to excessive red cell destruction, whereas a *direct positive* reading indicated that the bilirubin had passed through the liver and was now in a different form. This type of bilirubin, which some believed was no longer attached to a protein, was thought to be present in the serum of patients with obstructive jaundice. Intermediate between the indirect and direct positive was the *biphasic* or *delayed direct positive* result, which was supposed to indicate hepatitis. At the present time, both chemists and physicians are tending to be sceptical concerning the value of the Van den Bergh test and its interpretation. Distinguishing between haemolytic and obstructive jaundice does not usually present a difficult problem and, in the diagnosis of hepatitis, the test is of little value. The quantitative
indirect Van den Bergh test still remains, however, a useful method for measuring the serum bilirubin concentration.

(b) Bilirubin in the Urine. The simplest test for the detection of bilirubin in the urine is to add a few ml. of urine to a test-tube, cover the tube with the finger, and shake vigorously. If the urine contains bilirubin, the froth above the liquid will be stained yellow. A more sensitive method is the methylene blue test described by Myers (1945). The degree of bilirubinuria is usually greatest in patients with obstructive jaundice, less in patients with hepatitis, and least in patients with jaundice due to excessive red cell destruction. In patients with jaundice the bilirubin in the urine, like the concentration of the bilirubin in the serum, forms a convenient way of following the progress of the disease.

(c) Urobilinogen (plus Urobilin) in the Urine. This can readily be detected qualitatively using Ehrlich’s reagent, or quantitatively by the method of Watson (1936). The metabolism of urobilinogen in patients with different types of jaundice has been investigated by Steigmann and Dyniewicz (1943). Normally the concentration of urobilinogen in the urine is low. In the urine of patients with complete biliary obstruction it falls to zero. In the urine of patients with excessive destruction of red cells the bil pigment metabolism is accelerated and there is an increase in the urobilinogen of the urine, but the increase is not as great as that observed in the bile pigments of the faeces. In haemolytic jaundice the urobilinogen of the urine gives a good estimate of the progress of the disease. In patients with hepatitis the urobilinogen of the urine is greatly increased because urobilinogen, absorbed from the gut, is not taken up by the liver to be re-excreted in the bile, but is present in the systemic circulation, from which it is excreted by the kidney. As the disease progresses, the urobilinogen in the urine becomes less, usually falling to zero at the height of the illness. There is often a further increase in the urobilinogen excretion as the patient recovers. This test is, therefore, of value in following the progress of patients with hepatitis.

(d) Bile Pigments in Faeces. There are a number of chemical methods for investigating the bile pigments of faeces. Most of them are rather complicated and exceedingly unpleasant to perform. An inspection of the faeces is usually sufficient to give an adequate idea of the amount of bile pigment present. Inspection of the faeces, together with an estimation of the serum and urine bilirubin and the urine urobilinogen, is of more value in the differential diagnosis of jaundice than all the Van den Bergh tests that have ever been done. In patients with haemolytic jaundice there is a great excess of pigment in the faeces; in patients with complete obstruction to the biliary tract there is no pigment in the faeces at all; and in patients with hepatitis there is an increase in the faecal pigments, which may become progressively less during the course of the illness, with more pigments again as the patient recovers. Inspection of
LIVER FUNCTION

the faeces is thus an excellent method of following the progress of this disease.

(2) **Protein Metabolism**

The liver synthesises the albumin of the plasma and may also synthesise the plasma globulin and some of the abnormal proteins which are found in the blood of patients with liver disease. As a result, an examination of the proteins of plasma has been used as a test of liver function.

(a) **Total Plasma Protein.** In parenchymatous disease of the liver the plasma albumin falls, but at the same time the plasma globulin rises, so that the total plasma protein gives little information concerning the function of the liver.

(b) **Albumin/Globulin Ratio.** Since the plasma albumin falls and the plasma globulin rises in the blood of patients with parenchymatous liver disease, the albumin/globulin ratio must be less. In healthy persons this ratio is usually greater than 1.5, but in patients with hepatitis the ratio is frequently less than 1.5, and a positive correlation has been found to exist between the lowering of the albumin/globulin ratio and the severity of the liver damage, as observed histologically. As the patient recovers from the disease, the albumin/globulin ratio returns to normal. In patients with obstructive jaundice the albumin/globulin ratio is normal at first but, as the disease persists, the ratio may fall because, although the plasma globulin remains unchanged, the plasma albumin often falls. Since other factors, e.g. malnutrition (see Walters, Rossister & Lehmann, 1947) cause a change in the albumin/globulin ratio, this must not be considered specific for liver dysfunction.

(c) **Takata-Ara Test.** This test was described by Takata and Ara in 1925. For a description of the technique, the reader is referred to Soffer (1935).

(d) **Colloidal Gold Test.** For a description of the technique of this test, see Gray (1944).

(e) **Thymol Turbidity Test.** This test was described by Maclagan (1944) and an adequate description can be found in the original paper.

(f) **Cephalin-Cholesterol Flocculation Test.** This test was described by Hanger (1939), and the reader is referred to the original paper for the technical details.

The above four tests all depend upon the fact that abnormal proteins are found in the blood of patients with parenchymatous liver disease. Of recent years, much work has been done on the nature of the abnormal substances which cause each of these tests to become positive. For instance, Moore et al. (1945) found that it is an abnormal protein, which moves in the electrophoretic field with the β-globulin, that causes the cephalin-cholesterol flocculation test to become positive. The test is more
likely to be positive if the serum albumin is low, and is not affected by the concentration of lipids in the serum. On the other hand, Racant et al. (1945) state that the abnormal constituent which causes the thymol turbidity test to become positive is not in the $\beta$-globulin fraction, but is some other globulin. The concentration of serum albumin does not affect the test, but it is affected by lipids.

Whatever be the cause of each of these tests becoming positive, they all do so when the parenchyma of the liver is damaged, and consequently all the tests may be considered together. At the present time the thymol turbidity test and the cephalin-cholesterol flocculation test are popular and, since they are easier to perform than either the Takata-Ara or the Colloidal-Gold test, many prefer to do these two tests only. As a general rule, both tests are positive in hepatitis and negative in biliary obstruction, at least in the early stages. The thymol turbidity test is usually positive in acute liver disease, such as virus hepatitis, whereas the cephalin-cholesterol flocculation test is usually positive in chronic liver disease, such as chronic cirrhosis (Watson and Rappaport 1945).

(3) Serum Alkaline Phosphatase

The alkaline phosphatase of the serum can be measured conveniently by the method of King and Armstrong (1934), or by that of Bodansky (1933). The source of the serum phosphatase, whether it is of hepatic or extra-hepatic (bone, kidney, intestinal mucosa) origin is a vexed question and will not be discussed here. In patients with biliary obstruction the serum phosphatase is usually higher than 30 King-Armstrong Units or 15 Bodansky Units/100 ml. In patients with hepatitis the serum albumin is usually higher than normal, but seldom as high as is found in biliary obstruction. The test is, therefore, useful in distinguishing between these two conditions. In hepatitis there is no correlation between the severity of the liver damage and the serum alkaline phosphatase, nor is there a rapid fall in the alkaline phosphatase, as there is in the serum bilirubin, during the recovery phase of the disease. In patients with biliary obstruction the alkaline phosphatase rises as the obstruction persists, but again there is no correlation between the serum alkaline phosphatase and the severity of the liver damage.

(4) Carbohydrate Metabolism

The liver is able to form glycogen from glucose and other sugars, such as fructose (laevulose) or galactose.

\[
\text{fructose} \rightarrow \text{glycogen} \\
\text{galactose} \rightarrow \text{(liver)}
\]

If either fructose or galactose is given by mouth (oral tolerance test) or intravenously (intravenous tolerance test), the rate of disappearance of the sugar from the blood stream gives an estimate of liver function. Many carbohydrate tolerance tests have been put forward as tests of liver function.
Liver Function

function. At present the intravenous galactose tolerance test is popular. For the technical details of this test, the reader is referred to the paper by Sherlock (1946). Synthesis of glycogen from galactose is impaired when there is damage to the liver parenchyma. Thus the test is usually positive in the early stages of hepatitis, and rarely positive early in the biliary obstruction. In a general way, the degree of impairment bears some relation to the severity of the disease, but the test is not a sensitive one and the correlation is not great. In biliary obstruction the impairment of galactose tolerance may increase, as the duration of the obstruction increases and the liver parenchyma becomes damaged. From the technical point of view, the test is tedious and it is doubtful whether the information gained justifies the effort necessary.

(5) Detoxication

The liver plays a leading part in the detoxicating mechanisms of the body. An example of a detoxication process that has been used as a liver function test is the combination of benzoic acid with the amino acid glycine to form hippuric acid.

\[
\text{COOH} + \text{NH}_2 - \text{CH}_2 - \text{COOH} \rightarrow \text{C.NH.CH}_2.\text{COOH}
\]

Benzoic Acid  Glycine  Hippuric Acid

The hippuric acid formed from the combination of benzoic acid with glycine is excreted by the kidney. Sodium benzoate is given, either by mouth or intravenously, and the excretion of hippuric acid measured in the urine. For the technical details of the now more popular intravenous test, the reader is referred to the paper of Quick (1940). The excretion of hippuric acid is also impaired when there is damage to the kidney, and it is essential that, at the same time as the hippuric acid test is done, the urea clearance is also measured.

Excretion of hippuric acid is impaired in hepatitis, especially in the early stages, but histological examination of the liver shows that there is little correlation between the severity of the liver damage and the degree of impairment of hippuric acid excretion. The test is of little value in gauging the progress of the illness. In the later stages of obstructive jaundice the synthesis of hippuric acid is also impaired, the greatest hippuric impairment being found in patients obstructed longest and with the deepest degree of icterus.

(6) Excretion

The liver excretes many substances by way of the bile into the gastrointestinal tract. The rate of disappearance of certain substances, previously injected into the blood stream, has been used as a test of liver function. Both bilirubin and rose bengal have been used in the past, but
at the present time bromsulphthalein, introduced by Rosenthal in 1925, is the most popular. For a description of the technique of the test, the reader is referred to the original paper of Rosenthal & White (1925). The excretion of bromsulphthalein is impaired in parenchymatous liver damage and also in biliary obstruction. The test is a sensitive one, but it is of little use in the differential diagnosis of jaundice. The test is of value in that it does give an estimate of the severity of the liver damage and also of the progress of the disease.

(7) Cholesterol Metabolism
(a) Total Cholesterol. In patients with obstructive jaundice the total serum cholesterol is greatly increased. In patients with hepatitis the serum cholesterol is usually less than 250 mg./100 ml., whereas in patients with obstructive jaundice it is usually above this figure. There is no correlation between the degree of liver damage and serum cholesterol and, in patients with hepatitis, the serum cholesterol may increase as the disease progresses. Thus, while this test is of little value in gauging the severity of the liver damage or in estimating the progress of the illness, it is of help in deciding whether the patient is suffering from biliary obstruction or hepatitis. A change in serum cholesterol occurs in a number of other pathological conditions and is in no way specific for hepatic dysfunction.

(b) Serum Ester Cholesterol. Greene, Hotz and Leahy (1940) claim that the liver controls the level of ester cholesterol in the serum. In patients with parenchymatous liver disease there is a fall in the serum ester cholesterol.

(8) Formation of Prothrombin
Prothrombin, an element necessary for normal blood clotting, is formed in the liver, probably from amino acids ingested in the diet. For normal prothrombin formation there must be an adequate supply of vitamin K.

\[
\text{Vitamin K} \quad \rightarrow \quad \text{Prothrombin}
\]

Dietary Animo-Acids (LIVER)

In the absence of vitamin K there will be a fall in the concentration of prothrombin in the plasma, and hence an increase in the prothrombin time, as measured by the method of Quick (1940). If the prothrombin time is increased, the determination should be repeated later, after the parenteral administration of 1 mg. synthetic vitamin K. This is the prothrombin response. Allen & Julian (1940), Lord and Andrus (1941), and Olwin (1941) showed that there is no prothrombin response in patients with parenchymatous liver disease.

DISCUSSION
Each test of liver function divides itself into one of three groups: in Group 1 are those tests which are positive when there is damage to the
parenchyma of the liver, i.e. tests which are positive in the so-called 'medical' jaundice of infective or epidemic hepatitis, homologous serum jaundice or transfusion jaundice, toxic jaundice, or cirrhosis. In Group 2 are the tests which are positive in obstruction to the biliary tract, the so-called 'surgical' jaundice with extrahepatic obstruction produced by tumor, stone, etc. In Group 3 are those tests which are positive in both these conditions.

**Group 1. Tests Positive in Damage to Liver Parenchyma**
(a) Increased urobilinogen in urine.
(b) Increase in bile pigments in faeces.
(c) Decrease in albumin/globulin ratio.
(d) Thymol turbidity test.
(e) Cephalin-cholesterol flocculation test.
(f) Impaired galactose tolerance.
(g) Impaired hippuric acid synthesis.
(h) Decrease in serum ester cholesterol.
(i) Decrease in plasma prothrombin (in presence of excess vitamin K).

**Group 2. Tests Positive in Biliary Obstruction**
(a) Decrease in urobilinogen in urine.
(b) Decrease in bile pigments in faeces.
(c) Increase in serum alkaline phosphatase.
(d) Increase in serum total cholesterol.

**Group 3. Tests Positive in Both Conditions**
(a) Increase in serum bilirubin.
(b) Increase in urine bilirubin.
(c) Impaired bromsulphthalein elimination.

The above classification holds only in the hypothetical uncomplicated case. It must be remembered that, in patients with hepatitis and damaged liver parenchyma, the condition usually progresses until there is intrahepatic biliary obstruction. In such an event, the tests of Group 1 are usually positive early in the course of the illness and later the tests of Group 2 also become positive. On the other hand, in patients with biliary obstruction, parenchymatous liver damage usually follows quite rapidly. The tests of Group 2 are thus usually positive early, and later, as the disease progresses, the tests of Group 1 also become positive.

One may well ask which, of all the tests presented, are the best suited to the two purposes of most interest to the practising physician: (1) the differential diagnosis of patients with liver disease and (2) a means of following the progress of patients with liver disease. My personal view is that a few tests, well chosen, are of more value, and certainly more economical, than the indiscriminate use of a battery of tests. I would commend the eight tests set out in Table 1. The table gives some idea of the findings to be expected in patients with parenchymatous liver damage,
in patients with biliary obstruction, and also in patients with haemolytic jaundice. All these tests can be done on a single blood sample and one sample of faeces and urine. The tests are technically easy to perform and no complicated schedule of specimen taking is necessary. If the investigations are confined to such a few tests, it is usually possible, without unduly straining the facilities of the clinical laboratory, to make weekly observations and so follow the progress of the patient throughout the course of his illness. It is indeed fortunate, and here I speak from the biased point of view of the laboratory worker, that the tests which are of the greatest value in the differential diagnosis of patients with liver disease and in the following of the patients with established liver disease are those that are simple to perform, and economical both in money and in man-hours.

**SUMMARY**

1. Many of the functions of the liver, especially those that have been used for liver function tests, have been described.

2. The use of each individual liver function test has been discussed for (a) the differential diagnosis of patients with liver disease, and (b) following the progress of patients with established liver disease.

3. Of greatest value for the practising physician are the following tests: serum bilirubin, bilirubin in urine, urobilinogen in urine, bile pigments in faeces, albumin/globulin ratio, thymol turbidity test, cephalin-cholesterol flocculation test and serum alkaline phosphatase.

<table>
<thead>
<tr>
<th>TABLE 1. Tests Recommended for the Differential Diagnosis of Patients with Liver Disease and for Following the Progress of Patients with Established Liver Disease.</th>
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<tbody>
<tr>
<td>Parenchymatous Liver Damage</td>
</tr>
<tr>
<td>Serum Bilirubin</td>
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<tr>
<td>Bilirubin in Urine</td>
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<tr>
<td>Urobilinogen in Urine</td>
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<tr>
<td>Bile pigments in Faeces</td>
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<tr>
<td>Albumin/Globulin Ratio</td>
</tr>
<tr>
<td>Thymol Turbidity Cephalin-Cholesterol Flocculation</td>
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<tr>
<td>Serum Alkaline Phosphatase</td>
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| Parenchymatous Liver Damage | Obstruction Biliary | Excessive Red Cell Destruction |
|----------------|
| Parenchymatous Liver Damage | increased | greatly | increased | slightly |
| Bilirubin in Urine | increased | greatly | increased | increased |
| Urobilinogen in Urine | greatly increased | decreased | no change |
| Bile pigments in Faeces | increased | decreased | increased |
| Albumin/Globulin Ratio | decreased | little change | increased |
| Thymol Turbidity Cephalin-Cholesterol Flocculation | | | |
| Serum Alkaline Phosphatase | slightly increased | greatly increased | little change |
BIBLIOGRAPHY


NARCOSIS IN PSYCHIATRIC DIAGNOSIS AND THERAPY
By Sidney Rosen, M.D.

NOMENCLATURE and HISTORY

When we discuss the recent applications of narcosis to psychiatric diagnosis and therapy we encounter a language difficulty. What shall we call our procedure? One of the popular names is "narcoanalysis," introduced by Horsley. In 1942, Grinker and Spiegel used the term "narco-synthesis" and around the same time Sargent emphasized the "abreaction" which is produced. Different workers have referred to their method of treatment as "narcocatharsis", "narcosuggestion" and "narcohypnosis." We will group these many terms under the designation "narcosis".

One of the first to report the effect of barbiturates on psychiatric patients was Bleckwenn, who, in 1930, noted that some cases of catatonic schizophrenia, under amytal narcosis, showed "normal lucid intervals with spontaneous speech, and took nourishment." Two years later Lindemann noted that a prenarcotic dose (3-7 grains) of sodium amytal, when given slowly intravenously, produced an altered mental state in both normal and mentally ill patients.

But very little more was published about narcosis therapy until World War II, when the need for quick methods of psychiatric treatment encouraged widespread use of the barbiturates intravenously. Sodium pentothal and amytal progressed a long way from the days when they were familiarly called "truth serums". They were of great value in treating acute war neuroses and now are finding their place in our armamentarium for civilian psychiatric therapy.

METHOD

Anyone who has observed patients in the first stage of anaesthesia is familiar with the peculiarly uninhibited behaviour which is then sometimes displayed. We achieve a very similar result with the use of intravenous barbiturates, but the latter have the advantage of being short acting and, therefore, more easily controlled. The barbiturates which have proved most satisfactory to date are sodium pentothal and sodium amytal, but many others are used.

A ten percent solution of the drug is injected slowly into a vein while a casual conversation is maintained with the patient. When he is talkative, mildly euphoric, "drunk", yet not too sleepy to co-operate, the injection is stopped. A total dose of from 0.1 to 0.8 grams is usually required and it is injected at about 0.1 grams per minute. The effect of the drug is maintained for about one-half to one hour.
NARCOSIS IN PSYCHIATRIC DIAGNOSIS AND THERAPY

At first the patient may be encouraged to use free association methods and relieve himself of tensions. Later he may be diverted toward discussion of relevant material—about the symptoms and contributory factors. After about one-half hour of this, the therapist may apply suggestion and explanations. In other words, the usual psychotherapeutic methods are used, but they are facilitated and speeded up by the effects of the barbiturates.

EFFECTS

The effects of the drugs do not appear to be specific, but are common to other hypnotics and sedatives. They vary with different patients. We may compare the reaction of a patient with that of a person under the influence of alcohol. He may become excited or may retire into sadness and solitude. This behaviour is influenced by many factors, including repressed emotions, the dominant personality of the patient and outside stimuli.

Hoch, however, states that the action of the barbiturates differs from some other narcotics by releasing mainly words rather than actions, and by showing a more uniform response with different personality types. Alcohol, for example, releases actions as well as words, while cocaine produces marked variations with different personalities. Apparently all of these drugs act, in different degrees, by releasing the co-ordinating and inhibiting functions.

Thoerner, as a result of his experiments with intravenous amytal in man, concluded that the various divisions of the nervous system are affected in order of their phylogenetic appearance. In animals, however, Keese and Keeseer found that specific cells of the diencephalon had a characteristic affinity for the drug. Other experimental work has yielded differing results and we are left with as vague an understanding as we have of all anaesthetics—with the feeling that there is much more work to be done.

The effects which are noted by Ripley and Wolf include drowsiness, euphoria, detachment, and willingness to discuss intimate personal matters. Neurologically, the patients show nystagmus, vertigo, dilated pupils, decreased corneal reflexes, staggering gait and diminished reactivity to painful stimuli.

Sargent believes that it is important to produce an "abreaction"—the release of emotions about both repressed and remembered happenings. He deliberately tries to excite the patient to relive painful experiences and to become greatly excited. To do this he uses combinations of different stimulants with pentothal—including coramine, benzedrine, and intravenous methedrine as well as ether. He points out the similarity between abreaction and sudden religious conversions following induced states of great emotional excitement. At revival meetings, for example,
the subjects are stimulated repeatedly to shout, weep, shake with fear and to release normally repressed emotions. This state may continue for hours with collapse and fainting attacks, but then the convert suddenly "sees the light," finds his mind "clear", and feels "free" of old feelings of tension and guilt. His "clear" mind is super-receptive and is free to accept new patterns of behaviour. In the case of the convert these consist of a new religious belief. In the case of a patient undergoing narcosis therapy they may consist of a new outlook on life—free from neurotic fears and tortures.

USES

The uses of the intravenous barbiturates may be considered as diagnostic, prognostic, and therapeutic.

1) Diagnostic

Before sodium amytal and pentothal were adopted by psychiatrists they were famed as "truth serums". They are still used as such—sometimes to extract the truth from a malingerer and sometimes to determine a true diagnosis of a patient's condition.

a) Differentiation between a psychosis and a neurosis.

Often, under the influence of the drug, patients will disclose evidence of a true psychosis — hallucinations, delusions, mannerisms, incoherence, bizarre associations, which they had not admitted or manifested previously. These are not the result of drug delirium, because they are produced with only a small amount of barbiturate and can usually be verified later.

b) Distinction between functional and structural disease.

Symptoms, such as urinary retention, post-concussion headache, paralysis, blindness and low back pain, may be either structural or functional in origin. Sometimes we can alleviate these symptoms with suggestion alone, but often narcosis renders the patient more accessible. If the disturbance is temporarily relieved under narcosis therapy we can decide that it was functional. If results are negative we still have not ruled out a functional origin, and other methods must be employed. Sometimes the etiology of the disorder may be discovered at the same time.

During the war amytal and pentothal were often useful in discovering malingerers. Men who were undergoing treatment for a supposed functional disturbance would sometimes confess that they had faked their symptoms to dodge distasteful duties. In peacetime this application is not so important, but narcosis may find a similar use in the differentiation of industrial goldbrickers.

2) Prognostic

Harris and others used amytal before trying insulin or metrazol shock. They concluded that the more normally a patient acts under amytal narcosis, the better response they expect from shock therapy.
Hoch comments that the results often concur, but not always. After clinical recovery with shock treatment the symptoms often reappear when the patient is subjected to amytal narcosis. This finding leads us to wonder whether or not there is a really permanent cure of these mental diseases with shock therapy.

3) Therapeutic

There is some disagreement in the literature regarding the type of case which is helped most by narcotherapy, but all authors agree that the best results are obtained in neuroses. In psychoses, when narcosis therapy is used alone, the effect is only temporary,

a) Neuroses

During the first World War an attempt was made by Hadfield, Simmel and others to treat war neuroses with hypnotism, but this was a difficult procedure to carry out, it was not always successful, and cases often relapsed. As we have already mentioned, a number of men began to use intravenous barbiturates, during the second World War, to bring about the same type of mental state. Barbiturates were more easily given, their technique could be better standardized and the results were more encouraging. Hypnotism is still used, however, in some cases and is preferred by some men.

We must remember that the injection of a drug, alone, could not be expected to cure complicated mental disorders. The successfully treated cases received a full therapeutic regime, which included narcotherapy, psychotherapy, and rehabilitation. We might consider the barbiturates simply as auxiliary measures in the overall therapy of the patients.

In what type of case would we expect encouraging results? The response in war neuroses was often dramatic—especially in cases of short duration, such as hysterical blindness or paralysis in patients who had previously been in good mental health. When hysterical symptoms occurred in patients who were previously mentally disturbed the results were only temporary.

In civilian practice we may expect good results in simple anxiety or fatigue states with patients in whom there was no previous mental disease. These patients respond quickly and permanently as soon as they receive relief from the overstimulation of their nervous systems and forget the traumatic experience which brought on their anxiety state.

Obsessive cases—the brooders—respond less well and often only temporarily. Similarly those who express marked hostility during the therapy give poor response, since these manifestations suggest strong personality deviations underneath. In these cases, however, the dominating symptoms, such as fear or obsessions, were relieved, allowing the therapist to probe deeper and attempt to reach the more basic disturbance.
In cases of pains of undetermined etiology—the common back pains and abdominal pains which defy the surgeons and internists—good results are often obtained through the use of narcosis. Ripley and Wolf report that most of these cases show at least temporary disappearance of the symptoms with this treatment. The psychodynamics of the illness is probed and a special mental state is induced which renders the patient more amenable to suggestion. These authors also report cures in other conditions which they consider to be psychosomatic in origin. They describe, for example, cases of asthma, vasomotor rhinitis, low back pain and frigidity which were relieved by the use of sodium amytal.

Hoch describes other psychosomatic conditions which had responded to narcotherapy—often after being refractory to intensive psychotherapy for years. He tells of a case of stomach ulcers, and one of colitis, which cleared quickly after their mechanism had been discovered in a short time under narcoanalysis. He also describes successful treatment of "traumatic neuroses"—symptoms following head injuries. In two cases of post-traumatic headache the symptoms were quickly relieved with one therapeutic session under sodium pentothal. As can be imagined, the patients responded to the relief of their headaches with increased confidence in the therapist and were subsequently relieved of their symptoms.

b) In psychoses.

As we have already mentioned, narcosis therapy, alone, results only in temporary improvement of psychotics. But when sodium amytal is employed immediately after insulin shock very good results have been reported in cases which had not responded to either method alone. Of 11 cases treated by Levy and Perry, including paranoid and catatonic schizophrenics, manic depressives (depressed), and psychoneurotics of the anxiety and conversion types, all but one recovered or were greatly improved for at least six months.

Negativistic patients have always presented a very difficult nursing and feeding problem in mental hospitals. Steckler, Seidenberg and Harris are substituting "amytal feedings" for the crude tube feedings which require force to feed a patient. The patient is given an intravenous injection of amytal with strong suggestions that he should eat and that he feels hungry. In this way undernourished patients may eat two or three helpings without the physical and psychological shock which is associated with the old "forced feedings".

DISADVANTAGES and DANGERS

In treating mild disturbances caution must be used, lest severe anxiety or depression result when the patient relates his repressed conflicts. In order to avoid this it is a wise precaution to deal with less fundamental conflicts at first. Questions which might recall more significant conflicts may then be cautiously added. Whenever there is evidence of undue anxiety or depression the patient should be reassured and
diverted, and the discussion should not be pushed further at that interview.

Is there a danger of addiction? There is no true addiction with barbiturates, such as we see with morphine and cocaine, but habituation occurs. Hoch reports that he has seen no bad results to date and patients do not even ask for oral sedatives following narcosis therapy.

In cases where the neurosis is deeply ingrained narcosis fails, but intensive psychotherapy often fails also. A combination of different methods may succeed.

**SUMMARY**

Under the name "narcosis" we have discussed a rather new form of psychiatric therapy. The most common method which is now used is to administer a short acting barbiturate intravenously, but other drugs and other procedures are used. By carefully controlling the dosage of the drug a mental state is induced in which the patient is relaxed, uninhibited and very prone to suggestion.

The diagnostic, prognostic and therapeutic applications of narcosis have been outlined, and it was concluded that best results are seen in neuroses of short duration and in some "psychosomatic" disorders. In more long-standing neuroses and in psychoses narcosis therapy may be a valuable adjunct to other forms of treatment, and may help in establishing a diagnosis.

It has dangers, as has any form of treatment when carelessly employed, but its prime advantage is that it may considerably shorten the duration of therapy in selected cases. Narcosis, then, is another aid in our treatment of mental disorders. It must be considered along with other methods—regular psychotherapy, psychoanalysis, shock treatments, sedation, hypnosis. It may be useful alone or in combination with any of these other procedures. More work must be done to clarify the indications for its use, and to determine its mechanism of action.

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PROBLEM OF THE PHANTOM LIMB

By W. Graham '49

Introductory

PHANTOM part, or the so-called phantom limb, is an illusion that a missing part, usually an extremity, remains as an integral part of the body's make-up. This phantom part may be perceived as being normal in both size and posture or, as in many cases, it may take the form of a miniature of the original, often with postural distortion. Occasionally, only a portion of the amputated limb represents the total phantom. It is readily admitted that there is no comprehensive explanation for the phenomenon of phantom limb, yet there is definitely such a symptom complex, and to dispose of it as a neurotic condition adds nothing to the present knowledge of the subject and serves no useful service as far as the present is concerned.

History

The phenomenon has been recorded as early as 1551 by Ambroise Pare, but it was not until 1871 that Weir Mitchell published his article, "Phantom Limbs", and gave us this perfect term which has since had universal usage. He wrote: "A person in this condition is haunted, as it were, by a constant or inconstant fractional phantom of so much of himself as has been lopped away—an unseen ghost of the lost part, and sometimes a presence made sorely inconvenient by the fact that while but faintly felt at times, it is at others acutely called to his attention by the pains or irritations which it appears to suffer from a blow on the stump, or a change in the weather." The same Weir Mitchell went further into the problem by studying 90 patients suffering from the condition and the important observations he made may be used to explain the sensory ghost and its misbehaviour. He noted that if the track of the nerves in or above the stump of an amputated extremity be faradised, the lost digits may be flexed or extended and phantom parts of which the patient is conscious, but which he has not tried to move for years, may thus be made to move to his utter amazement. In a case of amputation at the shoulder joint in which all consciousness of the limb had long since vanished, Mitchell suddenly faradised the brachial plexus and the patient was at once aware of his missing hand which was posturally distorted and painful. Mitchell therefore, in his early work, established that nerve stimuli passing along the severed nerve fibres in the amputation stump, were the cause of the phantom phenomenon.

Statistics

The phantom parts are found to vary in nature and incidence. Mitchell found that 90% of patients experienced phantom limb after ampu-
Problem of the Phantom Limb

tation; Pitres 97%; Leriche 98% and Foerster 100%. Riddoch noted that pain was referred to the phantom in one half of all amputated limbs but Foerster claimed that pain was experienced in every instant. Mahoney observed that pain was felt in every phantom but it was disabling in very few (6%). Browden and Gallagher made a study of 100 adult patients with absence of one or more extremities. Of these, seven were born without one or more extremities and it was interesting to note that none of these had ever been aware of a phantom limb. Seventy-nine of the remaining ninety-three admitted phantoms and many of these stated that the ghost part had been present intermittently for years. Seventeen of the seventy-nine had what might be termed "burned out" painful phantom or transient phantom. An additional ten had enduring painful phantom or the pain of abnormal posture. The complaints of these ten appeared to be of two entirely different types. The first and most outstanding is the unalterable, often distorted posture of the phantom with a resulting cramp-like pain mostly in the distal part. The digits of the phantom are frequently described as "dug into" the palm or sole respectively and the part is said to be clenched in a vice in this fixed distorted position. The second type of pain is a deep-seated burning, and persistently boring discomfort also limited to the distal part of the phantom. The patients described as having the transitory phantom all described only the second type of pain, i.e. deep-seated, burning, persistently boring. It may be possible therefore to differentiate between a transitory and persistent painful phantom by the type of pain described by the patient. Added to this, patients with enduring painful phantoms have little if any change in the severity of the pain, whereas in the transitory group the pain progressively diminishes in a week to ten days following amputation. In the transitory group of seventeen, ten were free from pain a month after amputation but a painless phantom persisted intermittently for years.

General Considerations

The sensation of the phantom limb occurs more frequently in the hand than the foot and although it may occur immediately, it more frequently appears two or three weeks following the operation of amputation. Occasionally, a period as long as a year or more may lapse before the syndrome develops. Usually, as has been stated, only the more distal part of the limb is felt even though the whole arm or leg has been removed. In the course of time, the phantom recedes and ultimately comes to be attached to the stump. The phantom part may move voluntarily or involuntarily; it may be in a cramped posture and quite frequently assumes the position of the part before the amputation. This is found to be true especially in cases of traumatic amputation. Wounds, and parts of the limb previously painful may be experienced in the phantom as they were beforehand.

The unpleasant sensations experienced may include undue warmth, itching or simply the distress due to overconsciousness of the painless
phantom. These discomforts may be intermittent, but if severe, are usually continuous. They are then described as a dull ache or as burning, throbbing, piercing, cramping pains. Many patients suffer a deep agonizing torture due to the sensation of the limb being very tightly compressed which may be so severe that the victims are willing to undergo any type of treatment. It has not been unusual for a dozen or more operations to have been performed on one patient. Many ultimately end in morphine addiction or suicide.

**Differential Diagnosis**

True painful phantoms must be differentiated from stump neuralgias and the so-called stump causalgias. Causalgia infrequently follows major amputations. A cold, clammy, sweaty and cyanotic hand or foot associated with a burning type of pain commonly appears after a minor amputation such as a digit. The stump and regional area is exquisitely sensitive, the slightest superficial touch or thermal change often precipitates an explosive burning type of pain that radiates up the extremity and lasts long after the stimulus has been removed. A phantom digit may be present but the causalgic pain is not referred to the absent part. Actually there should not be too much difficulty in differentiating this disorder from painful phantom part.

Neuralgias of the stump appear to fall into two main categories. One is a more or less continuous dull ache, aggravated by pressure and said to be more severe in damp weather. It would seem to be attributable to some pathological alteration in the cut ends of the nerve trunks and muscles. The second and most common type of stump neuralgia is associated with excessive mesoblastic and axonal growth at the cut end of a large peripheral nerve. The pain here is described as electric like and shooting. It is often initiated by pressure or mechanical stimuli. Painful stump neuromas of course may be combined with phantom limb and this is only to be expected as the phantom part is almost a constant sequel to a major amputation. The pain however under such conditions is entirely different from that of painful phantom. The pain in the stump neuralgia is intermittent, sharp and shooting in character and is said to arise in the stump and radiate into the phantom rather than reside in it. On the basis of the history and physical findings, these neuralgias, too, should be readily differentiated from painful phantom limb.

**Theories to Explain Phantom Phenomenon**

Explanations for the phenomenon have been proposed by almost everyone who has probed into this baffling problem. Pare, who made the first suggestion, considered the retracting divided nerve fibres responsible. Mitchell reproduces the phantom by electrical stimulation of the nerve stumps, thus emphasizing a peripheral mechanism as the cause. His observations were complemented by Pitres who injected cocaine into the region of the neuromas, thereby stopping the disturbing sensations. More
evidence was offered by Souques and Poisot who injected cocaine around the terminal scar, causing a constant disappearance of all hallucinations which could not be reproduced by electrical stimulation during the period of anaesthesia. Thus considerable evidence was accumulated over a period of three and one-half centuries which pointed very clearly to the major roles played by the peripheral nerve stumps in producing this bejaue syndrome.

The participation of higher centres was recorded by Head and Holmes in 1911. While studying the sensory disturbances following cerebral lesions, they observed that one of their patients suffering from phantom limb was relieved immediately on the occurrence of the cerebral lesion. The stroke which abolished all recognition of posture, destroyed at the same time the phantom limb.

The part played by the autonomic nervous system has been emphasized by Leriche and Livingston through relief of pain, although temporary, which has followed interruption of the sympathetic nerves. There were also not a few supporters of a purely psychological explanation. Pick was probably the first of these and since him, others have gone so far as to maintain that the phantom and the associated pain are a state of mind without organic basis. Thus the origin and perpetuity of phantom limb have been attributed to all parts of the individual from the skin to the psyche.

Much psychological discussion has been offered to explain phantoms but before blaming all on the state of mind of the unfortunate sufferer, the simple physiological facts should be exhausted. The observations of those men previously mentioned should not be forgotten for they demonstrate clearly an organic basis which will explain the pathogenesis of phantom limb, i.e. peripheral nerve stimulation reaching consciousness. The vagaries of individual phantoms are beyond analysis. It might well be pure speculation, to give a reason for a phantom hand to gradually find its way to the height of the amputation even to the axilla. It is impossible to say why one patient experienced a rough skin on the dorsum of his phantom hand and a smooth skin on the palmar side; or why another spoke of his phantom as having a yellow color. It is also difficult to explain why, although phantoms are experienced universally, not all are painful and if so, why the pain varies so much in degree and time, even allowing for the inherent differences of the brain in which the peripheral stimuli register. The bizarre nature of the discomforts is also a bit of mystery but it is probably due to the unregulated conglomerate stimuli which assemble in the stump before marching to the consciousness. The various positions which the limb assumes are also not easily explained although it is thought that the imagined posture of a phantom limb is due primarily to dysfunction of the suprasegmental (i.e. thalamo-cortical) rather than segmental (i.e. spinal) circuits. As has been stated
previously, a number of these cases retain the posture of the limb at the
time of amputation; especially when this has taken place with violence as
in accidents or warfare. The position most frequently described for a
phantom limb, abduction of the upper arm, flexion and pronation of the
forearm and flexion of the hand and fingers is one which can be repro­
duced by massive electrical or mechanical stimulation of any one of the
large nerve trunks of the arm. Not only do the muscles innervated by the
nerve stimulated, be it median, radial or ulnar, contract, but the entire
extremity is moved reflexly so that the arm is abducted, the forearm
pronated and flexed and the hand and fingers powerfully flexed. The vivid­
ness of the phantom has been explained by Foerster as due to a cortical
engraving which was made by the strength of the impulses originating at
the time of the amputation or trauma. This engraving then is more
readily receptive to subsequent unorganised peripheral stimuli and is
prepared to interpret them as previously experienced.

Probably the most concise explanation has been given by White who
states that the primary cause of the phantom sensation is probably irrita­
tion within a neuroma of centrally conducting axones which formerly
supplied the missing part. However this does not necessarily continue to
be the case in view of the other peculiar characteristics of the phenom­
enon mentioned and the fact that these persist after all the known afferent
connections have been severed. Riddoch has given a most convincing
argument for believing that the phantom sensation is a projection arising
from the post central sensory association areas in the cerebral cortex.
According to him, stimulation by the process of healing of the proximal
ends of the divided nerve evokes sensations which are projected and
interpreted as if the limb were still present. As has been said, they are
never quite normal. These paraesthesiae, through simultaneous excitation
of the schema underlying tactile localization and shape are projected, and
animate the surface or outline model of the absent part. Similarly, irrita­
tion of fibres concerned with postural sensibility (probably thalamo-cort­
ical) give rise to impulses which help to keep alive the postural model so
that the phantom is correctly placed and moves with the stump. These
sensations, however, in the absence of pain, are weak, so that as a rule
only the peripheral segments, the hand or foot, which are most richly
endowed with sensory end-organs and fibers are represented in the
phantom. Retention of the phantom is in part due to abnormal qualities
of the tactile and other sensations, in spite of their relative weakness and
the antagonistic evidence from visual and other senses. During the
stabilising process of healing of the divided nerves, sensory impulses
diminish and sensations become correspondingly fainter with the dual
result that the phantom is increasingly less obvious in outline and pro­
jection of it is defective. In consequence, it gradually approaches the
stump into which it finally disappears. A new shape of the body is now
accepted. In other words, there is no longer a conflict in evidence from
the patient’s senses. If, however, the phantom is painful, which is usually
the result of grossly abnormal conditions in the stump, the phantom may persist indefinitely and retain its original position. Further, the hand and fingers are not only much more obtrusive and clearly defined, but more of the amputated part is represented in the phantom. If this concept of central projection is correct then it is to be expected that its development would take time to become established in the sensory cortex and this point has been mentioned by Riddoch and emphasised by Symonds. So it is, that most phantoms appear two to three weeks even up to a year following the operation of amputation.

**Treatment of Painful Phantom**

It is not within the scope of this paper to discuss the treatment of causalgias or the neuralgias which result from the amputation of a part of an extremity. Suffice it to say that patients with causalgias are usually relieved by either surgical or chemical interruption of the sympathetic pathways serving the affected part. The stump neuralgias are best treated by resection of the neuroma and revision of the stump. While the results of these measures are at times only transitory, they are at present probably the best procedure at the surgeon's command. In unusual instances it may be necessary to perform anterolateral chordotomy.

Hilton considered pain in the nature of a protective mechanism, but in a painful phantom it becomes a destructive mechanism, dangerous to the patient's morale. When pain of this type is allowed to become chronic, the cerebral cortex may become involved in its projection and in addition the patient usually develops an addiction for morphine. These complications make it imperative to define the ideal time for surgical intervention. Occasionally the pain subsides spontaneously but more often than not, it continues to get progressively worse. James C. White declares that a waiting period of over six months in any but the most stable individual is dangerous because the psychic changes may become irreparable. It is therefore necessary to formulate a rational plan of treatment for these patients and with this in mind we shall consider the surgical treatment of the problem after all conservative orthopaedic, physical therapeutic and neuropsychiatric procedures have been thoroughly tried and failed.

In undertaking this type of surgery then, principle number one should be to guard these patients against useless and mutilating operations. It is vitally important not to undertake any ineffective procedures as the pain in an amputation stump is usually increased by any operative procedures even to revision of flaps where the severed stumps of the major nerves are not even exposed. It is therefore of extreme importance to recognize that certain procedures are useless and should never be employed. Many methods of treatment have been tried such as revision or reamputation of stumps, excision of stump neuromas, division of nerve
trunks at higher levels, various types of injections aimed physiologically at interrupting the peripheral nerve of the stump, dorsal root rhizotomy, anterolateral chordotomy, paravertebral alcohol injections, peri-articular sympathetic ganglionectomies, sympathectomy, electric shock therapy, hypnosis psychotherapy, excision of the corresponding part of the post-central cortex and frontal lobotomy. In September of last year, a meeting of military neurosurgeons drew up a list of non-beneficial and actually harmful procedures which include the following:

1. **Repeated resections of neuromas.**

2. **Neurectomies or interruption of nerve trunks at higher levels.**

   Numerous case reports are on record which attest the futility of such actions. Another variation of this procedure is the transection of a painful nerve trunk with immediate suture to prevent neuroma formation. Leriche describes its use but without striking results.

3. **Reamputation.**

   This must never be considered as the pain nearly always recurs in the new stump and usually is made a great deal worse. The one exception to this rule is when a stump is badly constructed and a liability on mechanical grounds. A reconstruction may be in order in such a case but it must be done at an early date if it is to have any chance of relieving pain.

4. **Periarterial sympathetic ganglionectomy.**

   Successful results have been reported in cases of minor amputation. Leriche states that it should not be considered when the pain is severe. White considers the procedure to be nonspecific and that the effects are due to the transitory rise in peripheral circulation that results from the increased elimination of heat following any injury to the tissues. Similar effects can be produced more simply by procaine.

5. **Intrathecal injection of alcohol.**

   This has been advocated for painful amputation stumps of the lower limb. Its success is inconsistent and carries with it as great a risk of paralysing the bladder as section of the spinothalamic tract, or even greater. In any of these patients with chronic pain who are even fair surgical risks, White prefers to cut the pain tracts in the spinal cord.

6. **Posterior rhizotomy.**

   Sectioning the posterior roots of the brachial and sacral plexuses is a dangerous and mutilating procedure. The widespread and complete anaesthesia which results is both annoying and incapacitating to the patient if he has a useful stump. For this reason, and even more because the anaesthetic stump usually continues to be painful, this procedure should never be undertaken. Riddoch also emphasizes the futility of posterior rhizotomy in these cases and states that he has seen the pain
continue after the anterior as well as the posterior roots of the brachial plexus have been cut.

This same meeting drafted a number of procedures which they considered might be successful and they include the following:

1. Single resection of painful neuroma.

Some men claim that this operation never produces lasting results as the neuroma invariably recurs. Riddoch and White however are less pessimistic and of the opinion that removal of a palpable painful neuroma is worth a single trial provided the pain disappears when the neuroma is infiltrated with procaine. In excising the neuroma it is well to adopt the technique of embedding the end of the nerve in a drill hole made through a neighbouring bone so that the formation of a fresh neuroma will be prevented by the constricting action of newly formed periosted bone.

2. Sympathectomy.

When local measures fail, the possibilities of treatment by chemical blocking of the sympathetic fibers to the extremity or by gangliectomy should always be considered. It should be emphasised that there is no convincing evidence that the peripheral sympathetic axones carry any sensory impulses or that somatic sensory fibers run in these trunks to the peripheral blood vessels. Nevertheless sympathetic block has resulted in a large number of dramatic cures. It is always best to begin with a diagnostic blocking of the paravertebral ganglia with procaine. This is a simple test and occasionally a single injection will give enduring results. When freedom from pain lasts a number of hours or days the injection should be repeated, and Leriche and Homans in particular have found that in the course of a series of injections that the pain may be relieved for increasing intervals of time until finally it does not recur. If the improvement is only temporary, repeated blocks are not likely to be helpful but the chances of lasting relief following permanent vasodilation by sympathectomy are great. If the diagnostic injection of procaine does not influence the pain then treatment by sympathectomy need be given no further consideration.

It was felt by the committee that when these relatively innocuous types of surgery could not be used or failed, the attack had to be shifted to the central nervous system. However, before recourse to more radical intervention on the spinal cord or brain, all aspects of the problem should be reviewed with a competent neurologist and neuropsychiatrist.

3. Cordotomy or section of the spinothalamic tract.

Cutting the anterolateral pathway by which the sensation of pain ascends within the spinal cord is in general, far more effective than section of the posterior spinal roots. Furthermore it is not followed by numbness or loss of position sense as all components of sensation except
pain and temperature are spared. Success with this line of therapy has varied with the operator. However it is felt that after the pain has been present for a protracted period so that it has been stamped indelibly on the cerebral cortex, no spinal interruption can be counted on to free the patient from the consciousness of his phantom.

The results of the experiences of Browder and Gallagher have indicated that dorsal chordotomy seemingly abolishes the patient's knowledge of the posture of his phantom part and at the same time the cramp-like pain associated with the distorted posture. In one of their patients, partial section of the left dorsal column was carried out for the painful phantom in the left upper extremity and this did not result in demonstrable alteration in function of the homolateral lower extremity, thus demonstrating the feasibility of cutting a part of the dorsal column at this level (c. 2). The results of their operations to date have been satisfactory but not perfect, i.e. there has been significant relief from pain in the phantom although the phantom is still present and the pain is no longer troublesome. Sufficient time has not yet elapsed to make any conclusive statements regarding this procedure, however the outcome is not discouraging. Certainly the results are sufficient to justify continued effort and only through further observations will one be able to evaluate the effectiveness of the procedure in relieving painful phantom limb.

4. Resection of sensory cortex.

This line of therapy is made use of in the cases of phantom limb with evidence of psychic projection of the painful manifestations. The effectiveness of this surgical approach cannot be stated conclusively; however the theory can be tested by turning down a small parietal bone flap under local anaesthesia, indentifying the motor strip by electrical stimulation and then infiltrating the first post central convolution with procaine. Extirpation of the appropriate sensory area from the cerebral cortex is open to the serious objection of potential post operative epilepsy.

Horrax of Boston has reported one patient treated with cortical excision for post-amputation pain. This patient had received a crushing injury which required immediate amputation of both forearms just above the wrist. Pain in both stumps began directly after operation and continued unabated despite peripheral operations. A small area was excised from the right post-central gyrus and there followed a period of relief from pain which however recurred slowly and was as bad as ever in two weeks' time. Despite this, a cortical excision was made on the left side with relief of pain for a period of three weeks, when the pain again returned and was as bad as ever. This case was obviously a failure but the workers believed that there was a large degree of psychic trauma in this particular patient and he was therefore probably not a suitable example. One point of interest, however, was the statement of the patient that for the first time his phantom hands felt relaxed and were no longer in a cramped position.
5. **Frontal lobotomy.**

A final possible approach to the problem of the unbearable phantom is the elimination of the sufferer's introspection and self-centred concentration on his condition which is the natural outcome of long standing intractable pain. It must be emphasized, however, that lobotomy, as well as resection of sensory cortex for intolerable phantom, must be regarded as purely experimental procedures which will require extensive investigation before their therapeutic value can be estimated. At present, neither of these operations should be considered except under pressure of extreme suffering where all else fails and the patient threatens, unless relieved, to deteriorate into hopeless invalidism.

Frontal lobotomy too is open to the same objection as resection of the sensory cortex, namely, potential post operative epilepsy plus the additional hazard of post operative personality changes.

As yet, nothing has been said of the treatment of phantom limb pain by means of psychotherapy, hypnosis, or electric shock. It is generally felt, I believe, that the pain has an organic origin, nevertheless, it is interesting to see the results of some of these cases treated as a psychogenic problem.

1. **Electric shock therapy.**

The possible therapeutic use of electric shock is suggested by a case reported by Mahoney. A man, aged 40, developed pain in a phantom arm, two weeks after amputation at the shoulder. Fourteen months later he suffered a convulsive attack and following this attack, the phantom arm was present as before, but the pain had cleared remarkably.

Pisetsky, following this lead, tried the use of electric shock therapy as a method for the controlled administration of a convulsive seizure to produce the effect, more protracted if possible, which was observed in the above case. He has reported the case of a 55-year-old white male with both legs amputated below the knee in which a psychosis of the involutional melancholia type was precipitated by the accident. He continually complained of pain in both feet of the missing legs. The patient was depressed, harbored ideas of self-destruction and was agitated, irritable, and emotionally unstable. He had choreatic jerking of both legs and his prepsychotic history indicated that for years he was nervous and maladjusted. Electric shock treatment was instituted and after seven good grand mal seizures there was a marked personality change, he was euphoric, and admitted that his phantom limbs had disappeared but he had not been aware of their gradual disappearance. This patient has been followed for one year and has not had a remission. Electric shock therapy has long been recognized as beneficial in the treatment of involutional melancholia but the noticeable incident is the disappearance of the painful phantom limbs. Pisetsky suggests that it is very possible that there
was a high emotional factor in this particular patient's condition, and that his total reaction to his injury and his maladjustment to it were of greater importance and overshadowed any sensations that seemed to arise from his missing members. Specifically, therefore, this form of treatment would be recommended in selected cases only, where markedly depressive trends and suicidal tendencies accompanied the painful phantom and where other forms of treatment had proven ineffectual. Furthermore, all the physical prerequisites for electric shock treatment would have to be met.

2. Psychotherapy.

It has been suggested that phantom pain occurs in those individuals who are having phantom sensations, but who by reason of psychopathology, interpret the phantom sensations as being unpleasant and painful. It was noted that those describing phantom sensations and those describing phantom pain used the same descriptive adjectives such as twisting, burning, pulling, etc., but in most instances they are regarded as annoying sensations and are not interpreted as pain and no sedative is taken for them. The unstable individual tends to interpret these same sensations as painful and gets into the vicious circle of taking larger doses of sedative for the pain which in turn becomes more severe, requiring more sedation. In other words, the patients complaining of phantom pain are individuals who have considerable psychopathology complicating their orthopaedic picture and this psychopathology is determined to a certain extent by the degree of trauma accompanying the amputation of the extremity. If phantom pain is merely the interpretation by some individuals who show psychopathology of a phantom sensation (conceded to be of organic origin, either peripheral or central), then it is reasonable to assume that phantom pain is curable by psychotherapy, and Ewalt, Randall and Morris have reported two cases which support this view.

Summary and Conclusion

In conclusion, I should like to summarize some of the main points offered by this paper.

1. Phantom sensation and probably some degree of phantom pain is present in every case of extremity amputation.

2. Severe and sometimes intractable pain occurs in some 6% of phantom limbs.

3. Phantom sensation is believed to have organic origin in stump neuromata, possibly central projection.

4. Severe phantom pain may be due to some gross abnormality present in the stump or perhaps an associated psychopathology.

5. This paper has presented various therapeutic measures, surgical and otherwise, with the suggestion that certain procedures should not be tried. The important principle, that these patients should be guarded
against useless and mutilating operations is of vital importance and should be kept constantly in mind.

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A N increased interest in the problems of the aged has been a natural outcome of the continued success in disease control. Shakespeare's Sixth Age of Man was probably a description of a rarity in his day — an old man. Today Dublin predicts that by 1960, 9% of our population will be over 65 years of age. Shakespeare ends his description with "Sans teeth, sans eyes, sans taste, sans everything." Contrast with this the slogan of The Gerontological Society, "To add life to years, not just years to life." In the past few years there have appeared at least two new journals devoted entirely to problems of the aged and aging; and nearly every journal has some article pertaining to this group. It is obvious, then, that our profession has accepted the responsibility of the care of the aged and is applying both Medical Science and Medical Art to the problem.

It is my opinion that the first problem in Geriatrics is the mastering of an understanding philosophy by the younger men in Medicine. I can not believe it is either jealous or a lack of compassion which prompts some of us to say that certain oldsters have had their life and that it can now be discarded because it has so little time left no matter what is done. We should know that the attainment of old age is a promise for an even older age. A seventy-year-old woman has an expectancy of well over 10 years. A couple of 80 can each expect an average of five more years. Even a man or woman of 100 years has an expectancy of more than a year and a half! This thought should temper one's judgment in problems of the aged, whether medical or surgical.

The problem of surgery in this group under discussion is as in all other age groups, divided into elective and emergency operations. It behooves all concerned to educate the patients in the point of view that certain disease processes are amenable to elective surgery but that undue delay may force an emergency procedure so that the chances of recovery are greatly diminished. This is particularly true with uterine and bowel malignancies and the many types of urethral obstruction.

The management of surgical emergencies in the aged depends on a series of individual problems and therefore generalities are difficult to enumerate. All of the fundamentals of geriatric surgery should be remembered and variations as required are adapted to the situation. One should always consider ways of converting an obligatory situation by minor emergency procedures into an elective mode of management.

Where elective surgery is to be undertaken an outline of the whole course of events should be kept in mind. The factors to consider range from the preoperative care on through to the convalescence and complete
rehabilitation of the patient. Attention to the preoperative management pays as many dividends as any other part of the care. A prime factor for consideration is the nutritional state of the patient. The store of essential food substances is usually low. Shakespeare's observation of sans taste and sans teeth gives the most probable reason for this. That elderly people adapt peculiar food fads is notorious. That the essential proteins in meat should be deficient is obvious. Therefore plans should be made early to increase the intake of essentials. This regime should then be carried on throughout the whole surgical course. Attention has been drawn to the normal fluid electrolyte intake and the maintenance of an adequate protein balance. The protein needs are essential not only for cellular nutrition but also to prevent loss of fluid into the tissues. The necessity for vitamins C and K particularly, should be realized and probably the best way to attack this problem is with multi-vitamin therapy.

An analysis of tissue reserve should be made. Kidneys, blood, heart and liver are the crucial organs about which we should be concerned. One should do a complete urinalysis and some kidney function test — a simple concentration test should suffice. An N.P.N. will not show reserve but the lack of it. An E.K.G. and a two-step test are essential and a study of the cardiac shadow by x-ray is advisable. Hemoglobin determinations should be made and one should attempt to raise them to an adequate surgical level. Low hemoglobins should be studied by a blood smear. A total and differential serum protein will show the picture of protein reserve and to some extent the existence of liver reserve. A correction of a lack of tissue reserve should be made if possible; if not, then a knowledge of its existence will dictate a closer attention to its potential dangers.

Immediate preoperative care includes a rebolstering of the patient's confidence in the surgeon and anesthetist. The method of doing this is apparently an art and is gained only with experience. Another problem is the use of preoperative chemotherapy and antibiotics to allay complicating infections. This is still a matter of individual preference.

American writers in particular, are advocating frequent preoperative ligation of the femoral veins for the prevention of pulmonary emboli.

Preanesthetic drugs still are almost routinely Morphia and Atropine. The use of Scopolamine and Demerol have their advocates. Respiratory depressant action of drugs must be as closely watched as in a child. Barbiturates are usually too prolonged in action. Elderly patients are usually easily sedated and overdosage should be guarded against. The anesthetic agent itself should be one which produces a minimum of visceral damage. Cyclopropane seemingly is the most commonly used agent. A recent topic of discussion has been the adjunctive use of local anesthetic agents. In any event the anesthetist should be alert to prevent obstruction to the airways and should always maintain a proper amount of oxygen. "An old patient has neither physical nor chemical reserve to permit depletion of
oxygen." Although spinal anesthetics are often used these should be limited to low levels because high spinals are poorly tolerated by the older person.

Principles of conservative operative technique in the extremity of life seem to be most valuable. Rowntree makes the statement that "an hour of gentleness is safer than ten minutes of trauma." Sclerotic vessels and friable tissues make "gentleness" the by-word. A slight tug on the mesentery may cause a serious tear. The staging of operations is advisable in many instances. The elderly patient can not stand operative shock for a great length of time, so a recuperative period of a week to a month between stages may show the road to success.

The consideration of postoperative care in the patient beyond middle life is important. There are certain factors for consideration which are peculiar to the aged. Favorable cardiovascular response must be limited in a group where cardiac reserve, rigid arteries and hypertension are prone to exist. In a closed system of rather incompressible tubes such as make up the cardiovascular system of the old, a sharp decrease in blood volume can not be readily compensated for by vaso-constriction. Likewise the replacement of blood volume can not be as heroic as in younger people because the only expanding part of the system is the heart chambers and the patient is soon found in cardiac failure. The cardiac reaction to overload by increased rate and output is diminished. Fluid replacement should therefore be slow and should be constantly watched. Wherever it is possible the fluid should be replaced by natural routes. An intrarectal drip is suggested where as much as 5 pints of fluid can be absorbed per day. Normal rate of intravenous fluid flow in the elderly patient is suggested as 100 cc. per hour.

The factor of arterial tension is under the control of the anesthetist during the operation. An agent should be used which will have the least effect on the tension. A person with hypertension should have a high pressure level maintained. A drop may upset the tissues or lead to thrombosis. Another sidelight of this problem is that hemostasis obtained at a high level will hold at a lower level but that obtained at a low level may not be adequate if the tension goes up. Anuria, renal failure and uremia can occur if the hypertensive patient is not kept at a high level of blood pressure.

The prevention of thrombosis, pulmonary embolus and hypostatic pneumonia is a consideration of great importance. As mentioned before, there are numerous advocates of prophylactic femoral ligation. Postoperative heparin and dicoumarol has been suggested. Remembering that hypostasis is probably the common factor in each of these entities, it seems reasonable that early ambulatory treatment should always be attempted. Physiotherapy routines have been devised which will materially aid in the prevention of these common complications in the elderly patient. Breath-
ing exercises, massage, bed exercise and if possible actual weight bearing and walking follow rapidly in the post operative course. Pre- and postoperative penicillin will not only aid in the control of infection around the operative site but will aid in warding off a hypostatic pneumonia. Attention to fluid balance and blood pressure is essential in the prevention of intravascular thrombus formation. In the event that such a complication arises the immediate institution of anticoagulant therapy with Heparin and Discoumarol is advised. That these drugs need adequate laboratory control is to be emphasised.

The chemistry and metabolism of the elderly postoperative patient should be carefully watched—remembering again that tissue reserve has a narrow margin in these people. Where vomiting and diarrhea occur, rapid loss of body electrolyte occurs and a condition akin to intestinal intoxication in infants develops as rapidly as in this younger age group. Plasma chlorides and CO2 combining power are the laboratory methods best adapted to analysing the condition of electrolyte balance.

The respiratory system is prone to complications in the postoperative phase of surgery in the aged. Hypostatic pneumonia has been mentioned previously. Atelectasis is another complication which may be preventable. Three factors seem to produce this condition. First, the elderly person has a more rigid thoracic cage. Secondly, thick tenacious mucus collects in the bronchial tree during the operation and may plug part of the aerating system. Thirdly, the cough reflex is frequently retarded. Breathing exercises, postural drainage, and the anesthetist's attention to maintaining a clear air way will effect the first factor. The use of Atropine may be a partial cause of the second factor, and the use of too heavy sedation may be the cause of the third.

Kountz makes the statement, "With relation to the intestinal tract, age itself does not greatly increase the hazards of operation." It might also be remembered that malignancies in the aged are usually adenocarcinomas—the slowest growing of the malignancies. Another consideration is that the removal of the primary in the bowel will give great comfort to the patient even after metastases have reached the liver. This procedure may give as much as three years of comfortable life whereas a hopeless prognosis is in store if the primary is left.

Pain in the elderly patient can be a vexing problem. It may vary from an absolutely intractable pain to a simple discomforting pain which can be removed by aspirin. The aged patient's complaint of pain is often ignored because it is attributed to an inorganic basis. Pain reception is a part of the sensorium which seems to be slow to degenerate but the localization of pain may early disappear. The result may be an unexplained distribution and the temptation is great to explain it on a psychic or psychoneurotic basis. Therefore a clinical sixth sense seems to be necessary. The methods of managing pain are to remove the source,
surgically interrupt the pathways, block nerves locally or to raise the pain threshold. The skilled use of alcohol injection of nerves is dramatic in effect. Pain relief is often complete and lasts for some time. For patients past 60 it has been found that Morphine in 1/6 gr. doses gives the maximum analgesia whereas doses larger than this are mostly respiratory depressants. Demerol 75 mgm. is almost as effective as Morphine. Where the pain is due to vascular spasm, Demerol may be the drug of choice because of its tendency to relax smooth muscles. The analgesic effect of Demerol seems to vary between individuals, but where it is effective it is to be preferred. The use of codeine should be guarded in the early post-operative hours because of the depressant effect on the cough reflex and the hazards of atelectasis. An understanding of the patient’s reaction to his pain is necessary. If he understands the cause and the implications of his discomfort he may better be able to tolerate it. Because of this psychic background for pain, psychotherapy, Scopolamine or whiskey mouth may give great relief.

In the later stages of postoperative convalescence, attention to adequate rest, diet and general good health aid the prognosis. A bedridden invalid should rarely be called a successful outcome of surgical management. The same meticulous care in diet control exercised preoperatively, should be followed during the period of rehabilitation. Rest and exercise in amounts that maintain good tissue tone yet do not deplete the patient reserve are essentials in readjustment. A rebuilding of hemoglobin and attention to bowel habits for the comfort of the patient are necessary.

Extensive surgery in the aged is entirely feasible in our days. It is by strict attention to the principles outlined that the surgeon can truly "add life to years, not just years to life."

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This is a forceful and vivid autobiography of a woman who, at the age of eighty-four, is still active as a surgeon.

From the time of her birth in Michigan in 1863, until today, when she has reached the top in her profession, she has lived a full and eventful life which she describes in a disarmingly frank manner.

After an interesting, and often humorous, account of her early farm life, Dr. Van Hoosen tells of her college days at the University of Michigan and of her sudden decision to study medicine — at that time an unheard-of career for a woman.

Her troubles as a "hen medic" were many but after earning her own way through college she obtained her degree in 1888. Several years of hospital work followed before she set out to build up a practice in Chicago.

Dr. Van Hoosen’s book is particularly interesting because it deals with several chapters of medical history. Her dramatic accounts coupled with humorous incidents show us medicine as it was practised at the turn of the century. We learn of her attempts to enforce efficient sterilizing procedures in her operating rooms; of the introduction of twilight sleep in childbirth; in short, of the transition of medicine from the horse and buggy era to the procedures of today.

Extensive travels in Europe and the Orient have afforded Dr. Van Hoosen a wide knowledge of medicine and have allowed her many unusual experiences such as that depicted in her eye-witness account of one of Tokyo’s worst earthquakes, an event which she accounts from the time of the first tremor until she fled to safety on a train crowded with refugees.

"Petticoat Surgeon" is well written and will be enjoyed by everyone connected with the medical profession.

—K. Bandeen ’51.

RENNAL DISEASES

By E. T. Bell

Lea and Fabiger, Philadelphia, 1946, 434 pp. Price $7.00

This is a 434-page text on renal diseases by a fine pathologist who is
professor of Pathology at the University of Minnesota. It is the result of a compilation of studies on renal diseases personally carried out during the past twenty-five years.

Beginning with a splendid classification of renal diseases, the author discusses the structural changes, pathological physiology, and clinical manifestations of each disease in a simple, comprehensive style. The rationale of treatment is presented but the reader is referred to special papers for details of therapy. The relation of hypertension to the kidneys is discussed fully, and there is a discussion of the toxemias of pregnancy and the renal lesions in diabetes.

It is the author's desire to bring about a closer cooperation between pathologists and clinicians and consequently, this book is invaluable to both groups. It is an excellent text, moreover, for the final years in medicine.

From the technical point of view, it is par excellence; from the organizational and literary point of view, it is splendid. There are 115 engravings and 4 color plates. I recommend it highly to all.

—A. Di Francesco, '49.

400 YEARS OF A DOCTOR'S LIFE
Collected and arranged by
George Rosen, M.D., and Beate Caspary-Rosen, M.D.
Henry Schuman, Inc., New York 1947, 429 pp., $5.00

"What manner of man—or woman—is the doctor who intimately regards the patient and comes to know him so well, but himself remains a professional figure seemingly aloof from the common business of life?"

In answer to this question the authors present a selection of characteristic and revealing passages from the rich literature of medical autobiography. From Girolamo Cardano of 16th century Italy, to Walter B. Cannon, who died only three years ago, various members of the medical profession, some well known, and others less familiar, speak of their personal and professional life.

Recollections of childhood, school days, and medical studies; experiences encountered in medical practice, teaching, and research; family life and philosophical reflections; all are included in this anthology. Each excerpt is introduced by a short biographical sketch of the writer, which does much to ensure understanding of the passages.

This book was primarily intended for the layman. It should be of particular interest also to medical students and graduates, who would like to know something more of the personalities behind some of the names encountered daily in their work. The passages are brief; any one of them can be read in its entirety, no matter how short the period at one's disposal for relaxation. Reading at random, I found that no matter where I opened the book, I found something to hold my interest and attention.

—R. W. Street '51.
To Study the Phenomena of Disease without Books

Is to Sail an Uncharted Sea.
—Osler.

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December 15, 1948.
THE UNKNOWN DIABETIC
E. P. JOSLIN
Postgraduate Medicine, 4:302-306
(Oct.) 1948

Two main points are discussed in this paper. First, The unknown diabetic is an important factor in the revolution of the practice of Medicine. The one million known diabetics in the U.S.A. are equalled by a second million who are unknown. In finding these unknowns one should especially consider: (1) Age—examination of the over forty group is more revealing than the school age group. (2) Obesity—80% of diabetics are overweight. (3) Heredity—an easy way to find new diabetics. (4) Chemical examination of urine and blood. This should be done on specimens following a meal. (5) Incidence—highest in lower income groups.

Second. The problem is treatment and especially control of such large number under present conditions. Much of the efficient control of the patient has its basis in his or her education. The doctor has no time to do all that is necessary. Nurses’ aids, etc., over and above regular nurses, dietitians should be made use of to teach elemental things to patients under doctor’s supervision. Few patients can or need to be hospitalized.

Results of treatment are very encouraging. Figures of the Metropolitan Life show that life expectancy of diabetics 10, 30 or 50 years of age has constantly improved in the past fifty years.

Arteriosclerotic complications of diabetes have now replaced coma as main cause of death. Advances are being made here, too, in that figures for 300 diabetic children who have had disease for 25 years show that up to 8% are free from such complications.

The finding and control of the unknown early diabetic is an opportunity and a duty.
—H. BARKER, ’50.

CERTAIN REACTIONS FOLLOWING SPINAL PUNCTURE
M. L. EMORY, M.D.
American Practitioner, 11:451-456
(March) 1948

The author reports a series of lumbar spinal punctures performed on 779 patients in which there were no preliminary verbal preparations, although various methods were employed (e.g. In one method a sedative was given, whereas in another a stimulant was used, and yet the response was almost identical).

Generally speaking, the reactions may be divided into accidents of (1) hypertension, (2) hypotension, (3) shock, and (4) meningeal reaction. Negroes have consistently fewer reactions than white people, and it also appears that the female of both races is more prone to react than the male.

Headache and backache were the commonest symptoms; not all patients who had headache had backache; however, only a small number had backache without headache. Patients between 20 and 29 years were more subject to headache than were either younger or older groups, and the type of headache characteristically resembled that associated with meningismus. The presence of blood in the spinal fluid did not seem to have any appreciable effect on the incidence of spinal headache. On repuncture those patients who had previously had spinal puncture with headache had a significantly higher incidence than those who had not had headache with the previous puncture.

It is the author’s impression among a group of out-patients, who were not included in this study, that headache developed more frequently and more rapidly in those who travelled long distances by bus or automobile. Persons travelling 2 or 3 miles did not seem to be adversely affected.
As a rule, the headache does not develop until the patient has been in bed for his usually nightly rest; however, it is considered characteristic that spinal puncture headaches are relieved when a person lies down. If the patient is vomiting, normal saline infusions not only stop the vomiting, but relieve the headache. The average duration of headaches, whether treated or not treated, was three days.

The author concludes that postspinal puncture reactions show a high chance variation which is unpredictable, and at present two methods are being advocated to prevent these reactions: (a) Spinal Puncture with a double needle, (b) Cisternal Puncture. The double needle prevents chemical and bacterial meningitis by protecting the inner needle from skin antiseptics and microorganism. Cisternal puncture gives good results without these protective mechanisms.

—D. Sim, '49.

TWENTY-FIVE EASY WAYS OF GETTING INTO TROUBLE IN THE CARE OF FRACTURES
FRAISER B. GURD, M.D.
Am. J. Surg., 76:506-514 (Nov.) 1948

Outlined below are twenty-five easy ways by means of which any surgeon may reduce the effectiveness of his treatment of fractures.

A. Errors made before treatment—
1. Failure to assess associated traumatic shock.
2. Failure to diagnose concealed non-bony injuries. Such as ruptured abdominal viscera. There is a particular danger of overlooking injuries of patients under the influence of alcohol.
3. Failure to diagnose all concomitant fractures and associated complications. Of importance in this regard is the examination of all joints, and checking the integrity of major vessels and nerves.
4. Failure to obtain adequate x-ray pictures. In doubtful cases it may be necessary to repeat the x-ray at a later date when bone absorption would indicate the site of fracture. During the interval, such cases should be treated as fractures.
5. Failure to identify films. Be sure that the x-rays are those of the patient under consideration.
6. Failure to interpret the x-ray photographs. This is particularly difficult in carpal and tarsal bones and in pathological fractures.
7. Failure to recognize the mechanism of production of the injury. The patient's own story should be correlated with the x-ray films.
8. Failure to keep adequate records. Records should indicate the lesions present when the patient is first seen. It should also contain a note as to the state of arterial pulsation and possible nerve injury in any injured extremity.
9. Failure to notify all concerned of prognosis. This is particularly important if the results are likely to be unfavorable.

B. Errors during actual treatment—
10. Delay in fixation.
11. Delay in reduction—particularly in supracondylar fracture.
12. Inadequate reduction. Generally speaking, the better the reduction anatomic ally, the shorter the period of total disability and the better the end result. A common cause of distraction of bone ends is the use of too heavy traction procedure.
14. Repeated attempts at reduction. This is the most important single cause of acute bone atrophy—particularly near joints such as the wrist and ankle.
15. Excessive padding under plaster. This may contribute to slipping of bone ends or inadequate immobilization.
16. Technical errors during operation or application of plaster.
17. Errors in treatment of compound fractures. The most common errors are delay in operation, inadequate operation and over-confidence in bacteriostatic drugs and sera. The program in most cases should consist of conservative excision, wide incision, open packing and delayed suture.

C. Errors during the healing period—
18. Failure to maintain close observation during healing.
19. Failure to check maintenance of reduction by x-ray. A slipping of the bone ends following an adequate reduction is most likely to occur if the plaster is excessively padded, if the plaster does not include the joints above and below the fracture site or if considerable muscular atrophy has occurred.
20. The maintenance of the limb in a non-physiologic position.
21. The application of unpadded plaster while edema is yet present.
22. Failure to instruct the patient in the use of appliances such as crutches and the Thomas caliper.
23. Too early mobilization or unprotected weight bearing. This is a common and serious error which frequently leads to prolongation of disability and an increase in the amount of permanent disability.
24. Delay in rehabilitation. Factors to be considered here are diet, morale and local and general exercise including occupational therapy.
25. Too early and ill-conceived physiotherapy.

—M. Wear, '50.
SURGICAL TREATMENT AND PHYSIOPATHOLOGY OF COARCTATION OF THE AORTA

R. J. Bing, J. C. Handelsman, J. A. Camp-hill, H. E. Griswell and Alfred Blalock


Coarctation of the Aorta belongs to the groups of acyanotic congenital cardiovascular malformations. Diagnosis is not difficult, as there is usually hypertension in the upper part of the body, and hypotension in the lower part. There is usually increased collateral circulation in the upper part of the body, absence of arterial pulsations in the lower extremity. The stenosis can be visualized by angiocardiology.

The stenotic area is excised, and an end to end anastomosis of the proximal and distal ends of the aorta is carried out. There are some cases in which this procedure is impossible. These include persons whose atretic area is too long, and those in which the aorta is so diseased that end to end anastomosis is impossible. In these cases the left subclavian artery is used to by-pass the point of stenosis.

There are several points about the technique which are worthy of comment. An adequate exposure may be obtained by removing the fifth rib only. Because the intercostal arteries produce considerable bleeding on ligation and division, and because they are important collateral pathways, they should only be occluded by a rubber-shod clamp during the operation. To avoid occluding the subclavian artery during the operation, as well as the aorta, a modified Pott’s arterial clamp may be used. This permits some circulation through the subclavian artery. The clamp is introduced in the free space between the origin of the left common carotid and the left subclavian vessels.

Twenty-three patients with coarctation of the aorta have been operated upon by this surgical technique. Thirteen of the patients were twenty years of age and over, ten were younger. An anastomosis was completed in twenty-one of the cases. In seventeen of the cases the stenosis was resected, and an end to end anastomosis of the proximal and distal ends of the aorta performed. In four cases the left subclavian artery was used to by-pass the stenosis. There were three deaths, including one child, who had multiple congenital defects recognized preoperatively.

Physiological investigations disclosed no significant deviation in the cardiac output from the normal. Blood flow through the arm, which was elevated before the operation, fell following surgery. The blood flow through the leg rose post-operatively. Hypertension in the upper part of the body and hypotension in the lower part of the body were observed preoperatively. After operation these pressures tended to become equalized. Analysis of physiological data indicated no generalized elevation of peripheral vascular resistance. It is probable, therefore, the hypertension in coarctation of the aorta is not attributable to a renal pressor mechanism, but is due to resistance in the stenotic arc and the collaterals.

—F. J. Butson, ’50A.