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CONTENTS

	PAGE
USES AND ABUSES OF DIGITALIS	111
By F. R. FRASER, M.D., F.R.C.P.	
THE ROLE OF HYDROLOGY IN MEDICAL PRACTICE	115
By MATTHEW B. RAY, D.S.O., M.D. EDIN.	
EDITORIAL	126
POST-GRADUATE NEWS	127
NOTICES	iii
FELLOWSHIP OF MEDICINE AND POST-GRADUATE MEDICAL ASSOCIATION.—	
SPECIAL COURSES	iii

USES AND ABUSES OF DIGITALIS.

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ALL potent remedies are capable of causing harmful effects, and digitalis is no exception to this rule. The use of such a substance in therapeutics depends upon the beneficial effects being obtained by smaller doses than will cause toxic or harmful effects. There is, as it were, a gap between the appearance of beneficial and of toxic actions that constitutes the region of therapeusis. In dealing with patients suffering from circulatory insufficiency we must of course strive to obtain maximum beneficial results, and can do so only by approaching as closely as we can with safety to the phase of harmful or toxic effects. If the gap should close up it will be impossible to obtain beneficial

results and we will do more harm than good to our patients by using digitalis. It is important, therefore, to understand the possible actions of digitalis, to know when they may be utilized to the advantage of our patients, to understand clearly what it may be expected to do in any given case, what it cannot be expected to do, and to avoid harming our patients in an endeavour to help them.

The principles of its action have naturally been worked out more completely in animals than in man, but much careful work and analysis have been done on human subjects also, and we recognize three or four primary actions that can be of value in treatment.

(1) Digitalis interferes with the conduction of stimuli from the auricle to the ventricle.

(2) It increases the tone and the contraction of the ventricular muscle.

(3) It slows the sino-auricular node or pacemaker in the rapid action of failure.

A consideration of the mechanism of the heart beat and of arrhythmias that are

associated with circulatory failure indicates that the action of the auriculo-ventricular conduction can have no beneficial action when a normal sinus rhythm is present, but can be of great benefit in slowing the ventricles when auricular fibrillation is present and the ventricles are beating as rapidly as the conducting system can convey impulses to them from the chaotic activity of the auricles. The action on the ventricular muscle is not a powerful one, and doubt has been expressed whether such an action really occurs under clinical conditions. The evidence that this action really occurs in patients is, I think, convincing, and it should be beneficial in cases of dilatation of ventricles and in cases of enfeebled contraction of the ventricular muscle: that is to say, in all cases of heart failure. It is possible that the slowing of the pacemaker is really a secondary action dependent on the improved ventricular contraction, but it is important to note that when a normal sinus rhythm is present and the action is rapid for reasons other than heart failure, as in such conditions as infection and high fever, or in exophthalmic goitre, digitalis is powerless to slow the heart.

As a result of these primary beneficial actions there are numerous secondary results that can be recognized at the bedside and are due to the improved conditions of the circulation. Diuresis takes place if œdema is present, the capacity for exertion increases, and the functional capacity of every organ and tissue is improved.

In addition to these primary actions on the heart and their secondary beneficial effects, there are actions on the central nervous system and the gastro-intestinal tract. Headache, drowsiness, mental depression, nausea, vomiting and purgation may be caused. The picture is often very similar to that of sea-sickness, and the patient lies in bed and does not like to be disturbed for anything—a thoroughly miserable picture. The vomiting and diarrhœa are sometimes partly due to direct irritation

of the stomach and intestines and dependent on the particular preparation employed, but they are usually late toxic effects through a nervous mechanism and indicative of digitalis poisoning. There are also effects on the heart that are undesirable and injurious and that are similarly indicative of too large a dose. They usually appear after the beneficial actions are obtained, and are due to an increased irritability of the heart muscle, or to the action on the conduction from the auricles to the ventricles. Partial or complete heart block, increased number of extra-systoles, coupled rhythm, and fibrillation of auricles and of the ventricles may be produced.

To treat patients it is necessary to know not only what actions we wish to obtain, but also the amount of digitalis necessary to obtain them. We want to know the amount that must be present in the body, and if we are to maintain the necessary concentration in the body we must know how quickly it is absorbed and also how quickly it is eliminated or destroyed. Clinical observations have shown that the total amount that must be given to obtain maximum beneficial effects without toxic effects is remarkably constant. If the drug is administered sufficiently rapidly that the rate of elimination can be neglected, Eggleston showed that 0.015 gm. of an average good leaf is necessary for each pound of body weight. For a patient weighing 10 st., or 140 lbs. that will be a total of 2.1 gm. of a standardized leaf, or 21 c.c. of the tincture (5 fluid drachms). The rate of absorption from the stomach is usually rapid, and a good tincture is usually completely absorbed in six hours. Because of difficulties in estimating the weight of a patient with œdema, because of the possibility of lesions in the heart that might cause an early appearance of undesirable toxic effects, and because of the difficulties in accurate standardization, it is not advisable to give the whole of the calculated quantity at once. Eggleston advised that one-third to a half of the

calculated amount should be given in the first dose, a fifth to a quarter six hours later, and an eighth to a sixth at further intervals of six hours. By this method full digitalis effects on the heart will be obtained in twelve to twenty-four hours, and definite effects in six to eight hours. This method of administration is particularly useful in auricular fibrillation with a rapid ventricular rate and serious symptoms of heart failure that require urgent treatment, but it is usually advisable to use somewhat smaller initial doses and withhold the later doses if signs of toxicity arise. I have found it convenient with patients of about 10 st. in weight to use successive doses of tincture of 6 c.c. (one and a half fluid drachms), 4 c.c. (1 drachm), and 2 c.c. (half a drachm).

In less urgent cases this rapid administration is not necessary, but it must be given more rapidly than it is eliminated, or full effects cannot be obtained. The rate of elimination is about 1.5 c.c., or 22 minims a day, in a patient who has received full doses, so that it is necessary to continue to give from 1 to 2 c.c., or 15 to 30 minims a day, to maintain the full effect and keep the ventricular rate down in the presence of auricular fibrillation.

When a normal sinus rhythm is present and the effect on auriculo-ventricular conduction of no value, the results are not so dramatic. The demonstrable results of the action of the drug appear more gradually, and as a rule the indications for its use are less urgent. When the full clinical effect has been obtained there is seldom any necessity for maintenance doses, as is the case when auricular fibrillation is present, but many clinicians advocate the continued use of doses somewhat less than the maximal for the sake of the tonic effect on the ventricular muscle.

Even when congestive heart failure is present, it is not always possible to obtain slowing of the ventricular rate, whether the rhythm be a normal sinus one or auricular fibrillation be present. This is seen in cases

of active infection of the myocardium, such as in acute rheumatism and septicæmias, and in the severe myocardial degeneration that accompanies coronary sclerosis. Such cases can be compared to cases of carcinoma in which the disease is so advanced that no benefit can be obtained by operative treatment. Toxic effects such as headache, mental depression, nausea and vomiting, appear before any beneficial effects are apparent, and continuance of the treatment by digitalis causes more harm than good. These obvious clinical signs of intoxication must be regarded as indications for stopping the administration and adjusting the dose to a lower level at which no such harmful effects are obtained. It is doubtful whether even those lower doses are of any therapeutic value in such cases.

There are other cases in which the toxic effects are seen first in disturbances of the rhythm of the heart. When the auriculo-ventricular conduction has been especially affected by disease, the digitalis effect of depressing the conduction is obtained with doses smaller than are usually necessary to produce this effect. If normal sinus rhythm is present, partial heart block may be produced with missed beats. This is rarely, if ever, of advantage to the patient. If auricular fibrillation is present, undue slowing of the ventricular rate will be produced. Rates below 60 or 70 per minute are usually too low for optimal results on the patient's efficiency, and doses lower than those indicated by the body weight of the patient must be employed.

In some cases the action of increasing the irritability of the heart muscle may appear early, and numerous extra-systoles occur and hamper the cardiac efficiency. Coupled rhythm is the familiar example of this action, and is a clear indication that no further ventricular slowing can be obtained. If the administration is continued in spite of the appearance of this warning, serious effects, such as ventricular fibrillation and sudden death, may be the result.

There is no foundation for the belief, which is expressed sometimes, that a high blood-pressure is a contra-indication to the use of digitalis. As a rule it has no effect on blood-pressure, but frequently when congestive failure is present and the pressure is high, it falls with the general improvement in the patient's condition following the use of digitalis; and when it is low it rises to a more normal level.

It is said to be contra-indicated also when aortic regurgitation is present. There is probably no special danger due to this valvular defect, but the cases in which this lesion is the most evident manifestation of disease are frequently suffering from arterial sclerosis or syphilitic disease of the heart and aorta, and are those in which the dramatic effects of digitalis are not to be expected, for the rhythm is usually regular, the ventricular rate not greatly raised, and the myocardial damage severe. Congestive heart failure with rapid ventricular rate is, as a rule, a late phenomenon in this type of case, but when present, and especially if the auricles are fibrillating, digitalis is indicated and is just as effective as when the aortic valves are competent.

There has been much discussion as to the place of digitalis in the treatment of pneumonia. This is due to a lack of appreciation of what it can be expected to do. It cannot be expected to slow the heart when normal sinus rhythm is present and the rapid rate is due to the fever and the raised metabolism. Any effect it may have by virtue of the action on the tone and contraction of the ventricular muscle is difficult to detect, but there is good evidence that this action is effective in pneumonia, and the action on auriculo-ventricular contraction is clearly manifest if the auricles fibrillate. If auricular fibrillation occurs about the time of the crisis, as is not infrequent, it may be of life-saving importance to have the patient already well under the influence of digitalis. I believe in giving digitalis from the beginning in pneumonia for the

effect on the ventricular muscle, and so that the patient is fully under its influence by the time such a serious complication as auricular fibrillation is likely to arise.

For many reasons, which are obvious, administration by the mouth is preferable as a rule to any form of injection, and we have seen that by this method effects can be obtained in a few hours if suitable doses are employed. There are urgent cases of heart failure in which the vomiting of failure may interfere with this method. Five to ten drops of tincture of opium, or of solution of morphine hydrochloride, given a quarter of an hour before the first dose of digitalis, usually overcomes this difficulty, but occasionally this is not efficacious. It may then be given per rectum, using the same dose of tincture diluted to 3 fluid ounces, or 100 c.c., with water. It is absorbed just as quickly and efficiently by this route. There are no satisfactory preparations of digitalis for subcutaneous, intramuscular or intravenous injection, but strophanthin is satisfactory for intravenous injection if the oral and rectal routes are impossible or undesirable. By this means a digitalis-like action is obtained in a few minutes. It can be given in amounts up to a milligramme a day in repeated doses of a quarter of a milligramme, or $\frac{1}{250}$ of a grain. It is not without grave risks, however, for if full effects are desired the dose must be very near that which will produce toxic effects, and once given by intravenous injection it cannot be withdrawn. When the oral route is used, excessive amounts are commonly rejected by the vomiting produced. The danger of giving strophanthin by intravenous injection is particularly great if digitalis has been given previously within ten days, or even more, on account of its slow elimination. An unknown quantity is still present, and the sudden addition of the strophanthin into the blood-stream may cause sudden death.

The tincture and the fresh infusion are both satisfactory preparations, if prepared

by reliable firms who employ methods of standardization, as is also, I believe, Nativelle's digitaline, but I have had little personal experience of it. Probably the most satisfactory preparation is the powdered leaf which may be given in the form of tablets. It is stable and convenient. It is being employed extensively already, and will almost certainly replace the older preparations to a very large extent. It is important, I am sure, to employ one preparation from a reliable firm on all occasions, and if you do so you will find not only that you will learn how to use digitalis more effectively, but also that you will discover much about your cases from the manner in which they react to it.

THE RÔLE OF HYDROLOGY IN MEDICAL PRACTICE.

POST-GRADUATE LECTURE DELIVERED FEBRUARY 11, 1930.

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THE term "hydrology" (or medical hydrology) has been widely employed on the Continent for many years. It has recently come into more common use in this country as a more euphonious and comprehensive designation than those respectively of hydrotherapy, hydrotherapy, balneology, crenotherapy (the internal use of mineral waters), and thalassotherapy (sea bathing), to denote the employment of water, either plain or naturally mineralized, as internal or external remedies.

Hydrotherapy, at its inception, besides implying the therapeutic use of water (mostly hot internally and cold externally), became elevated to a distinct cult, the adherents of which lost no opportunity of expressing

their profound distrust of any other method of treatment and thus ranged themselves alongside the homœopaths in opposition to their common enemy, the "allopath." With the advance of more liberal ideas the term has largely lost its original meaning and is now only used in association with hotel-like establishments equipped with bathing facilities.

Hydrotherapy came into use as an alternative title to hydrotherapy as it had no controversial implication. It is still employed, but in the general acceptance of the word is only applicable to baths.

Balneotherapy or balneology has only a restricted terminology in relation to bathing. The other designations, crenotherapy and thalassotherapy, are practically never used in this country.

As the term "medical hydrology" includes the external as well as the internal use of water, both plain and naturally mineralized, as therapeutic agents, it is convenient to consider the subject matter of the lecture under these two headings.

As indications for the therapeutic use of water externally are constantly arising in everyday practice, that branch of hydrology will first be considered, after which the internal employment of naturally mineralized waters which is included under the designation of "spa treatment" will be dealt with.

THE PHYSIOLOGY OF THE SKIN.

The organ most concerned in the therapeutic applications of water, or indeed any other physical agent—heat, light or electricity—is obviously the skin. A knowledge therefore of its reactions both in health and disease is of prime importance.

For this reason it is necessary to begin by referring to some physiological principles on which rational hydrotherapy is founded.

FUNCTIONS OF THE SKIN.

Excretory.—The sudoriferous or sweat glands play a most important part as excre-