The drugs did not kill the worms. When placed in drug-free medium all affected worms recovered in half to two hours.

In view of the similarities observed between the drug effects of piperazine against *A. lumbricoides* from the pig, *in vitro*, and clinical use of piperazine citrate against ascariasis in man, the relationship between the beginning of drug action, duration of narcosis, rate of drug excretion, and the intestinal emptying time of the host is discussed.

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CINERADIOGRAPHY OF THE URINARY TRACT

BY

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The great advantages which would accrue from being able to visualize the actual movements of the renal pelvis, calices, and ureter have been obvious to urologists since the advent of contrast media and the fluorescent x-ray screen. Many urologists perform their ascending pyelograms under screen control, but, although much valuable information can be obtained by this means, the small volume of opaque medium which can be used provides poor contrast as compared with a barium suspension in the bowel, while the light intensity is insufficient to provide really clear definition of the calices.

The fluorescent screen can, of course, be made brilliant enough for clear definition, and even for photography, by greatly increasing the screening current, and this is how the ordinary excretion urogram film is exposed. A high screening current is used for a very short exposure. Unfortunately the x-ray dosage absorbed by the patient during such an exposure is high and can be repeated only a few times with safety. Up to the present time fluoroscopy, and certainly photography, has been limited by this problem of having to choose between a low x-ray dosage with poor illumination for a reasonable length of time or a high x-ray dosage with brilliant illumination for a few seconds only.

An X-Ray Image Amplifier

However, this problem has now been solved by the use of an x-ray image amplifier, which, as its name implies, amplifies a poorly illuminated screen image by electronic means (Coltman, 1948; *British Medical Journal*, 1955).

The instrument is attached to an ordinary x-ray apparatus in place of the usual viewing screen, so that the x rays strike a metal screen inside an evacuated glass tube. Instead of producing a fluorescent image, this screen emits electrons which are greatly accelerated through the tube by a potential difference of 25 kV, and are kept in focus by several "electron lenses" until they strike a small, 1-in. (2.5-cm.) fluorescent screen at the other end. This is similar to an ordinary fluorescent viewing-screen except that the image is reduced in size to 1 in., but is extremely brilliantly illuminated. An optical system can now project this image either

through an eye-piece, on to a mirror system or, of greater importance still, into the lens of a cinecamera (Fig. 1).

A bright visual image of the renal shadow can be seen with a screening current as low as a half to one milliamperere, while cineradiography can be carried out with a current as low as 6 to 7 milliamperes in some cases.

Fig. 1.—Diagrammatic representation of Marconi image amplifier, showing path of electrons through tube, together with optical system of mirrors for visual screening. The retractable mirror, which is of a semitransparent nature, is used to reflect some 90% of the light into the 16-mm. cinecamera while still allowing the operator to see what is being photographed.

At the present time, using the Marconi or the Philips instruments, the area to be screened is limited to 5 in. (13 cm.) in diameter by the size of the image amplifier tube, but it is hoped that this will be increased in the not too distant future. For urological work this small field is only just large enough to cover the whole kidney in the average patient, but the potentialities of this new method of investigation are very great indeed.

Potentialities of the Method

Using one of the new rapidly excreted opaque media such as "hypaque," with its radiologically denser molecule, the slow movements of the calices can be clearly seen during excretion urography. The very marked influence which gravity exerts on the emptying of the pelvis has proved a great surprise, at least to me. For example, if the pelvis is filled from below with the patient lying flat, the calices may remain filled for an appreciable time after the catheter is withdrawn. If the table is now tilted towards the vertical position, the calices immediately increase their movements and the pelvis may empty in a matter of seconds. The study of delayed emptying in pelvi-ureteric junction lesions, of decubitus calculi, and many other problems will surely be stimulated by these new possibilities (Fig. 2).

As one would expect, a calix damaged by a calculus or by inflammation loses its contractile power, and the possibility of detecting early tuberculous lesions is being studied with some success.

The argument whether peristalsis is present in the ureter or not can now be answered. One can see and film the column of medium moving down the ureter from one segment to the next. One can also see the very active but

FIG. 2.—Emptying retrograde pyelograms. Pelvis filled with medium through a catheter which was then withdrawn. Fluid travels down ureter in a series of columns about 3–4 in. (7.5–10 cm.) in length. Each column is separated from its fellow above or below by one or more segments of empty, and presumably contracted, ureter. A column does not pass down to the bladder in one movement, but is always held up momentarily in the region of the so-called “ureteric spindles” before passing on to the next spindle. Each column has a clearly defined head and tail.

sometimes purposeless movements of a megaloureter, showing the medium forced upwards as well as downwards, but not necessarily out through the ureteric orifice.

A further obvious use of this principle is in renal arteriography, where the timing of the exposures in the past has been all-important. Using the intensifier and cinecamera, the whole cycle from injection to nephrogram and beyond can be continuously recorded. The great disadvantage at the moment is the limited size of the screen, since it is not always possible to include the aorta and the kidney in the same field.

It has already become evident that the interpretation of some of the unexpected phenomena which we are now seeing will require time and experience before their full significance can be assessed, but the potentialities appear great,

particularly in the study of hydronephrosis, ureteric spasm, aortography, and such problems of rapid muscular action as the micturating cystogram and ureteric reflux.

This work is being carried out with a Philips intensifier (Van Alphen *et al.*, 1952) for the Institute of Urology at St. Paul's Hospital, in conjunction with Dr. J. J. Stevenson; and, using a Marconi amplifier (Coltman, 1948; *British Medical Journal*, 1954), with assistance from the Medical Research Council, at Hillingdon Hospital in conjunction with Dr. F. G. Greenwood.

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