the chances thereafter will diminish with the lapse of time. It is doubtful if recovery would be obtained when movement in the toes was impossible or if anaesthesia of the sole of the foot and toes was complete. The treatment should be to explore the popliteal space, using a tourniquet only if haemorrhage should become uncontrollable. The ruptured artery and vein will readily be found, as the site of rupture is practically constant with the divided ends, not much more than one inch apart. Ligation of the proximal and distal ends of both artery and vein should be carried out. The blood clot should be expressed, milking it down from the thigh and ensuring a thorough clearance in the popliteal space and the region of the knee-joint. The wound should then be closed without drainage, and the treatment completed by giving a blood transfusion, for, though variable, in most cases it will be found that a considerable amount of blood has been lost.

No case is recorded apparently of arteriorrhaphy proving successful. Apart from tending to precipitate thrombosis it is extremely doubtful if it would lead to better results than ligation.

In view of the fatal case recorded here, the sole case encountered, criticism may be made of this somewhat dogmatic expression of opinion. The impression of the futility of conservative treatment was so vividly marked that immediate effort made in local treatment appeals as the only common-sense procedure holding out any chance of avoiding the tragedy of an amputation. Criticism levelled at the publication of an isolated case can be disregarded: the case is so rare that it is unlikely that many will be encountered in the practice of any single surgeon, and it is possible that others may profit by what, with the wisdom of after-knowledge, have been considered mistakes.

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In his report as director of the Molteno Institute for Research in Parasitology (*Cambridge University Reporter*, May 21st, 1935) Professor D. Keilin mentions that Dr. P. Tate and Miss Vincent have continued their work under the Medical Research Council on the action of new synthetic quinoline compounds on avian malaria. A number of these compounds were found to have a strong anti-malarial action, and one of them has a therapeutic index twice as great as that of plasmoquine. They also continued their work on the biology of English and Continental strains of the mosquito, *Culex pipiens*, which transmits bird malaria. Dr. H. P. Bayon investigated the effect of feeding liver to, and injecting liver extracts into, fowls suffering from the form of progressive anaemia described in 1929 as erythromyelosis. Feeding with liver, yeast, and iron increases the haemoglobin for a short time, but it does not stop the fatal course of the disease. The injection of liver preparations brings about a remarkable increase in haemoglobin and in the number of erythrocytes, the shape of which is also improved. A fowl lymphoma was transmitted by inoculation.

MECKEL'S DIVERTICULUM

BY

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Historical

Johann Friedrich Meckel, an eminent pathologist born in 1781, was the discoverer of Meckel's diverticulum of the intestines. He was considered the foremost comparative anatomist in Germany prior to Johannes Müller, and has been called the German Cuvier. Some of his best literary achievements consisted of his treatises on pathological anatomy (1812-18), normal human anatomy (1815), an atlas of thirty-three plates representing human abnormalities (1817-26), and his best work, "A System of Comparative Anatomy" (1821-30). Wolff's monograph, "The Development of the Intestine," was also translated by him. Meckel died when he was 52 years of age, in 1833, at the height of his career. His brother,

FIG. 1.

August Albrecht Meckel, became professor of anatomy and forensic medicine at Berlin in 1821, and died in 1829. Their father, Philipp Friedrich Meckel (1756-1803) of Berlin graduated from Strasbourg in 1777, and became professor of anatomy and surgery at Halle in 1779. He was the favoured obstetrician at the Russian Court. The grandfather of Johann Friedrich Meckel, of the same name, was born at Wetzlar in 1724. He graduated from the University of Göttingen, and at the graduation exercises delivered a notable dissertation on the fifth nerve, since known as Meckel's ganglion. He was the professor of anatomy and obstetrics in Berlin and the first teacher of midwifery at the Charité.

Embryology and Anatomy

Embryologists have demonstrated that, at the seventh week of foetal development, the mid-gut becomes completely closed off from the umbilical vessel (yolk sac) by the atrophy of the connecting yolk stalk. The point of final closure of the mid-gut represents a level on the future ileum, about two and a half to three inches above the ileo-caecal valve.

In approximately 2 per cent. of all individuals the intra-abdominal portion of the yolk stalk fails to disappear in a variable degree. This persistent remnant, an intestinal tubular appendage, is known as Meckel's diverticulum. The distal end may adhere to the

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

umbilicus at the anterior abdominal wall. Frequently it undergoes the same pathological changes as are seen in acute appendicitis cases. Embryonal failure to complete the process of duct atrophy not only results in Meckel's diverticulum, but also in umbilical anus and a variety of clinical and pathological conditions. Cases are recorded where it has been found to be within one metre proximal to the ileo-caecal junction.

Meckel's diverticulum may be the sole content of a hernia (Littre's hernia), or it may be present with other portions of the bowel. It has been found in umbilical, inguinal, and femoral hernias. Unless some anomaly of the umbilicus is present it is impossible to diagnose this condition previous to operation. The mucous membrane and outer coats appear well developed and normal. Microscopically it shows all the normal structures, including Lieberkühn's glands and Peyer's patches. Cysts developing from Meckel's diverticulum are rare, according to McGlannan and Black. Among the congenital causes of intestinal obstruction Meckel's diverticulum is generally accepted as the one most frequently present.

Reviewing the cases of this condition one is impressed with the fact that the great majority are admitted for appendicitis in adults and for intussusception in children. The favourite site appears to be about 40 cm. proximal to the ileo-caecal valve. The most frequent complication is appendicitis, which generally appears in the acute form in adults and as intussusception in children. Since the ages, in both adults and children, vary so much, no benefit is derived from this information.

Operative Procedures

In formulating operative procedures for Meckel's diverticulum the cases must first be classified as to whether there is a general, a local, or an absence of diverticulitis. In the suppurative gangrenous or perforating types, I am strongly opposed to any operative procedure other than the deliverance of the diverticulum out of the abdomen to a position above the parietal peritoneum. To accomplish this the adhesions must be freed and the mesentery incised, so that this inflamed tube may be elevated from its bed and be extra-peritonealized at all hazards as in Fig. 1. I disagree with those surgeons who, in the face of this grave danger, do a resection and enterorrhaphy. After the diverticulum has been delivered, the Paul-Mikulicz procedure may be used with the attached ileum. I have found this technique to be quite successful in dealing with conditions affecting the small intestine. Secondly, in those cases where only the dome or distal part of the diverticulum is inflamed, it is advisable to double clamp and use the technique of my new operative procedure illustrated in Figs. 2 to 5. I am opposed to the use of the inversion procedure (Fig. 6), since it merely removes the pathology from without to within the lumen, with consequent sequelae and complications resulting in the dangerous possibility of new growth or cystic degeneration, and, the most important of all, haemorrhage from ulceration and ileus from obstruction.

Unfortunately the popular and accepted operative procedure of excision leaves that portion of ileum wall

FIG. 6.—Inversion procedure.

FIG. 7.—Constriction when too much wall is removed.

FIG. 8.—Insufficient removal of wall.

which is congenitally weak. If too much of the wall is removed a constriction occurs (Fig. 7), and if not enough, as illustrated in Fig. 8, a recurrence of the same pathological condition can be expected, since only a weakened wall of gut remains. In my operative procedure (Figs. 2 to 5) the important step is the excision of the congenitally weak portion of the ileum, followed by its repair and closure. This is accomplished so that

the wall of the ileum does not in any way interfere with the lumen. As shown in Fig. 3, a diamond-shaped incision is made after removal of the diverticulum and congenitally weakened area. The closure is made by suturing A to A₁, B to B₁, and C to C₁. By the employment of this method there can be no stenosis, nor any tendency by the weakened wall to form another diverticulum.

BENEDICT'S QUALITATIVE TEST

A FURTHER MODIFICATION SUITABLE FOR ESTIMATION
OF URINE GLUCOSE IN WARD OR SIDE ROOM

BY

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A modification of Benedict's test has been described¹ whereby a quantitative result could be obtained, with sufficient accuracy for clinical purposes, by filtering the boiled mixture of urine and Benedict's solution and comparing the filtrate with a set of graduated blue standard tubes. This modification has the disadvantage that, under the conditions described, the Benedict's solution is completely decolorized by 2 per cent. glucose. Hence, if the filtrate is devoid of a blue colour the estimation must be repeated with diluted urine. If the test is repeated with urine diluted twofold and the filtrate is again colourless more than 4 per cent. glucose is present, and a third estimation, with urine diluted fourfold, is required for a more exact result. With this last dilution up to 8 per cent. glucose can be estimated.

Nicholson² has employed the same principle of estimating glucose by the unreduced copper of the Benedict solution rather than by the precipitate; he did not filter, however, but allowed the heated mixture to stand several hours. He also increased the range of glucose detectable up to 4 per cent. by employing 0.25 c.cm. urine + 5 c.cm. Benedict's reagent in the test. This device reduces the sensitiveness of the test to half, and in any case does not obviate the necessity of repeating it with diluted urine when more than 4 per cent. glucose is present. To avoid a succession of tests the following two alternative procedures are proposed.

Method I

To two test tubes each containing 5 c.cm. of Benedict's qualitative solution add 0.5 c.cm. and 0.1 c.cm. of urine respectively; a blood pipette should be used for delivering 0.1 c.cm. The tubes are placed in a beaker of boiling water, and after heating for five minutes the first tube is filtered, using Whatman's filter paper No. 50 (which is even better than No. 44 first proposed). If the filtrate is bluish it is compared with the standards and the second tube is disregarded. If the filtrate is water-clear or yellowish the

second tube is also filtered. The second filtrate is compared with the standards, and the result obtained multiplied by five gives the approximate percentage of glucose. A more accurate result is obtained by referring to the following table, which compensates for the error arising from using 0.1 c.cm. urine only in the second tube.

No. of Standard Tube	...	...	...	1	2	3	4	5	6
Corresponding percentage of glucose	Using 0.5 c.cm. urine			0	0.4	0.8	1.2	1.6	2.0
	Using 0.1 c.cm. urine			0.14	2.6	4.4	6.3	8.1	10.0

Method II

This procedure is identical with the modification originally described, 0.5 c.cm. of urine being heated with 5 c.cm. of Benedict's solution for five minutes in the water-bath and the mixture filtered. Urines containing under 2 per cent. glucose yield bluish filtrates, which can be compared with the standards already described. Urines containing 2 per cent. glucose yield a water-clear filtrate, owing to complete, but just complete, precipitation of the copper. Urines containing over 2 per cent. glucose yield filtrates which are yellowish up to about 5 per cent. and gradually become brownish at higher values. The colour is due to caramelization of the glucose in excess of 2 per cent., a smell of burnt sugar becoming more and more noticeable when more than 2 per cent. is present.

The caramelized filtrate is then compared with a series of standards representing 3, 4, 5, 6, 8, and 10 per cent. glucose. These standards can be prepared by heating a series of mixtures each containing 5 c.cm. Benedict's reagent and 0.5 c.cm. of a standard glucose solution (from 3 to 10 per cent.) in a boiling-water bath for five minutes and filtering as in the test. The filtrates are sealed or stoppered in tubes and appear to keep well, though on this point observations do not go beyond a few months.

It is important that tubes should be removed from the water-bath at *exactly* five minutes, since caramelization progresses with further heating. Thus 5 per cent. glucose heated with Benedict's reagent for six minutes gave a result of 6 per cent.; when heated ten minutes it was 8 per cent., and with fifteen minutes' heating it was 9.5 per cent. When less than 2 per cent. glucose is present, however, the same result is obtained whether heating is for five or for fifteen minutes.