admitted to a general hospital, have been investigated in detail from psychiatric and social aspects. The sample suggests that at least one-fifth of attempted suicides belong to this group.

A family history of psychiatric abnormality was obtained in 67% and of suicide in 14% of the cases.

Of the group 74% came from "broken homes." Previous suicidal attempts had been made by 45%. The majority of the patients were in the first half of life, and all had shown persistent social maladjustment; most typically they were impulsive, aggressive, restless, egocentric, and affectionless; many gave histories of unemployment, crime, sexual maladjustment, alcoholism, drug addiction. 71% were in the lowest social class.

The physical state was satisfactory in 60%.

Nearly one-third had not been complaining of nervous symptoms, and one-half were not under the care of a doctor at the time of their suicidal attempts. Homicidal trends were in several cases obvious. The majority of the suicidal attempts were impulsive, precipitated by a personal quarrel or the threat of retribution. Alcohol and fatigue were significant factors. Poisoning was chosen by 91%. Many were confused about their real intentions.

The psychopathology of these acts is described and the following motives are considered most significant: hate, evasion, identification with a dead person, fears, experimentation, the demonstration of omnipotence, and manipulation of the environment.

Of the group 86% were discharged home.

The difficulty of judging the seriousness of these attempts is discussed, their resemblances to the episodically disturbed behaviour of the epileptic and to the suicidal attempts of children and primitives are briefly considered, and the need for further research and its possible directions are indicated.

I am grateful to Professor Sir David Henderson for his criticism and advice, and to Dr. J. K. Slater for permission to study these cases in his wards at the Edinburgh Royal Infirmary. I am also much obliged to Miss Margaret B. Napier, senior psychiatric social worker at the Royal Edinburgh Hospital, for her assistance in obtaining data from the families of these patients.

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The decision of the Department of Health for Scotland to combine a publicity drive against tuberculosis with mass radiography surveys in selected areas is largely based on experience at Greenock. Here, last autumn, one-fifth of the adult population (13,537) came forward for x-ray examination, and as a result 58 previously unknown active cases of pulmonary tuberculosis were discovered—a yield of 4.3 per 1,000 of those examined. A further 93 patients (6.9 per 1,000) were placed under surveillance. It is pointed out that a far higher proportion of the population would have been x-rayed had not the radiography units been previously committed to routine work such as the examination of National Service men. The Department sums up the Greenock experience in these words: "The case for a change in emphasis in favour of mass x-ray drives is stronger when the incidence of active tuberculosis discovered in Greenock is taken into account."

MECKEL'S DIVERTICULUM AS AN ABDOMINAL EMERGENCY

BY

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"Meckel's diverticulum is frequently suspected, often looked for, and seldom found" (Charles Mayo, 1933). This vestigial structure may make its presence known dramatically, and the diagnosis is seldom made pre-operatively. Few surgeons have extensive experience of the condition, and this review is based on a small series of five cases.

Diverticula may be found anywhere in the gastrointestinal tract. Most of them are acquired and have their origin at the point of penetration of the muscle coat by the mesenteric vessels (Edwards, 1939). Among the congenital diverticula are the rare caecal diverticula and Meckel's diverticulum. Meckel's diverticulum is a remnant of the foetal vitello-intestinal duct, which in the foetus forms a channel between the midgut and the yolk sac. As distinct from acquired diverticula it is a true diverticulum, consisting of all the layers of the intestinal wall.

Pathology

Remnants of the vitello-intestinal duct may be encountered in the form of (1) a persistent duct from the ileum to the umbilicus with secretion of mucus, or even faecal matter; (2) a short umbilical sinus or an umbilical polyp; (3) a vitello-intestinal cyst; (4) a fibrous band from the umbilicus to a Meckel's diverticulum; or (5) the band may be attached to intestine, mesentery, or another viscus, commonly in the pelvis; (6) a solitary Meckel's diverticulum is the remnant most often found. An artery may be contained in the above band—namely, the vitelline artery.

The different intestinal diverticula were classified in 1812 by Johann Friedrich Meckel (the younger); he gave a full description of the solitary diverticulum of the ileum which bears his name. It had, however, been described earlier by others. Among the congenital abnormalities of the intestinal canal it has the highest incidence, and in necropsy materials it is found in 1–2% (Treves, 1918). Its average length is 2 in. (5 cm.) (varying from a slight bulge to a 6-in. (15-cm.)-long vermiform process), arising from the anti-mesenteric border of the ileum about 2 ft. (60 cm.) from the ileo-caecal valve, the distance varying from 4 in. to 5 ft. (10 to 150 cm.). It is shaped as a cone or a blunt cylinder protruding at a right angle, or more rarely at an acute angle from the intestine. Ileal mucosa lines its interior, but duodenal or colonic mucosa may also be found, and gastric mucosa is present in 16% of necropsy specimens (Schaetz, 1925). In the clinical material, however, gastric mucosa is encountered in two-thirds of the cases recorded (Schullinger and Stout, 1934; Bussey, 1938; Montant *et al.*, 1950). The French designation "petit estomac" is explained by these facts. Heterotopic pancreatic tissue may also be found.

Infection

Acute inflammation of Meckel's diverticulum, sometimes caused by foreign bodies, gives clinical symptoms and signs quite similar to those of appendicitis.

Case 1

A 5-year-old boy was admitted to Surgical Department A of Frederiksberg Hospital on March 30, 1952, with a diagnosis of appendicitis. He had been treated in the medical department for abdominal pain some months before. There had been short

spells of dizziness, nausea, and abdominal pain four weeks prior to admission. Another attack started the day before with abdominal pain. As the pain grew worse he was sent to hospital. On admission his temperature was 101.8° F. (38.8° C.), pulse 88. Tenderness was found below and medial to McBurney's point, and rebound tenderness and a dubious Rovsing sign were present, but no rigidity. A diagnosis of atypical appendicitis was made, and immediate operation was decided upon. At operation the thickened appendix showing moderate signs of inflammation was removed. As the changes found were not thought sufficient to explain the patient's symptoms, the terminal ileum was inspected. An inflamed Meckel's diverticulum 2.5 cm. long, about 3 ft. (90 cm.) from the ileo-caecal valve, was found and removed. Recovery was uneventful.

Histological Report.—Subacute appendicitis and diverticulitis Meckelii. The pathological changes in the diverticulum were described as more pronounced than those in the appendix.

Perforation

The clinical course is often more stormy than in appendicitis; inflammation may lead to gangrene, early perforation, and peritonitis. Cases of perforation peritonitis caused by foreign bodies, especially fish bones, have been described (see Fig.). Because of the ample and thin intestinal contents

Photograph of removed Meckel's diverticulum with fish-bone perforation, occurring in a 9-year-old girl. (Mr. Wallace Dennison, of the Royal Hospital for Sick Children, Glasgow, has given me permission to use this photograph.)

escaping into the peritoneal cavity and the meagre possibilities of walling off the inflammation at this site, the peritonitis arising is diffuse, and the outlook is more grave than in perforated appendix. Diagnosis is difficult; thus Sibley (1944) reports a case in which delay in operating, because of failure to recognize the inflammatory nature of the intestinal obstruction, led to death from peritonitis and septicaemia. This was partially due to the fact that the patient had been successfully carried through a previous attack with the Miller-Abbott tube and that he seemed to improve under conservative treatment at the beginning of the last attack. The diseased diverticulum may not be looked for at all if an inflamed appendix is found at operation. Discussing this problem, Aalkjær writes (1937): "In several of these cases no discrepancy has been found between the condition of the appendix and the peritonitis, and the surgeon has performed an appendicectomy. Some days later necropsy has revealed the perforated Meckel's diverticulum."

Case 2

A 13-year-old boy was admitted to our department on November 10, 1947, with a 36-hours history of abdominal pain about the umbilicus. The pain later moved towards the right iliac fossa; it was moderate and colicky and more pronounced after meals. He complained of nausea, but there was no vomiting. His bowels had been opened several times.

On examination his temperature was 99.8° F. (37.7° C.) and pulse 112. There were no signs of dehydration, and abdominal examination showed definite tenderness at McBurney's point and a positive Rovsing sign. Appendicitis was suspected, and immediate laparotomy was performed through a lower right gridiron incision; the abdominal cavity contained seropurulent fluid. The caecum was fixed and could not be moved out of the wound;

the terminal portion of ileum was found red and inflamed with no distinct line of demarcation. The appendix was difficult to find; it was very long and in the subileal position; it was removed. The changes found were less than those in the ileum, and the surgeon diagnosed ileitis terminalis and closed the abdomen.

The next day, at 3 p.m., the patient had sudden severe pains in his abdomen and a rise of pulse and temperature. Next morning it was evident that a perforation had taken place with subsequent peritonitis, and a further operation was decided upon. At operation on November 12 the abdomen was opened through a lower right pararectal incision. Fibrin-covered intestines were drawn forward, and a ruptured Meckel's diverticulum was found. A simple removal without intestinal resection was possible, and the wound was closed without drainage. Convalescence was uneventful.

Histological Report.—"Meckel's diverticulum with gastric mucosa, severe inflammatory changes and perforation through ileal mucosa. Endoappendicitis levissime gradu."

Intestinal Obstruction

This may be produced by a Meckel's diverticulum. According to Walsh (1949-50) it was the cause in 6% of a large series. A strangulation is the mechanism most frequently met (Lejars, 1921), as the intestine is kinked upon a band extending from the tip of the diverticulum to adjacent mesentery, to the abdominal wall, another coil of bowel, or a pelvic viscus. Sometimes a snare is thereby formed in which an intestinal coil is caught and strangled (Thomsen, 1927). The rarest mechanism is the formation of a real knot in a Meckel's diverticulum around the intestine. This can take place only if the diverticulum is long, mobile, and free, and has an ampullary dilatation of the distal end, designated by French authors as "la clef de l'étranglement."

Among 63 cases of intestinal obstruction caused by Meckel's diverticulum Halstead (1902) found a band in 48, and a band was the cause in 8 out of the 15 cases of Guilleminet *et al.* (1950).

Case 3

A 79-year-old woman was admitted to hospital on July 5, 1947, with a 24-hours history of sudden colicky pains across the abdomen accompanied by nausea and vomiting; no flatus had been passed. There was a slight rise of temperature and she showed signs of dehydration. A straight radiograph of the abdomen revealed dilated coils of small bowel and the erect film many small-bowel fluid levels. Conservative treatment with hot fomentations and fluid diet resulted in an improvement in her condition, and ample flatus and thin stools were passed the next morning. She gradually improved, and some days later another radiograph showed no signs of intestinal obstruction. She returned home on July 23.

On December 23, 1952, she was readmitted as an emergency case. There was a 9½-hours history of nausea, faintness, and later constant pains in the upper abdomen. The bowels had not been opened for 36 hours. On examination the patient was moaning and her tongue was dry. The abdomen was a little distended, but followed the respiratory movements. There was generalized tenderness, most pronounced in the epigastric region, but no rigidity. No tumours and no herniae were found. A pelvic examination gave no further information. Intestinal obstruction because of a tumour or constipation was suspected, and a straight radiograph was taken. Several dilated coils of small bowel and fluid levels in the erect position were seen. No gall-stones could be detected and there was no air in the bile ducts. Immediate operation was decided upon.

At operation the abdomen was opened through a lower right pararectal incision. The abdominal cavity contained a considerable quantity of serous fluid. Distended coils of small bowel filled with fluid presented in the wound. After some search a fibrous band extending from the great omentum to the tip of an inflamed Meckel's diverticulum, which had strangled an intestinal loop, was found. On section of this band the intestine regained its normal colour, and the obstruction had thus been removed. Excision of the Meckel's diverticulum was then undertaken, followed by closure of the wound. Convalescence was complicated by a slight inflammation of the wound. Histological examination showed a Meckel's diverticulum with no pathological changes.

Volvulus

Volvulus of Meckel's diverticulum, with or without involvement of the coil of ileum bearing it, is well recognized as one of the ways in which the diverticulum may precipitate acute obstruction of the small gut. The obstruction is of the "closed-loop" type, clinically characterized by violent intestinal colic and absence of peristaltic sounds (Smith, 1945). It is a rare lesion; in the 15 cases of Meckelian obstruction of Guilleminet *et al.* mentioned above there was only one case of volvulus. Intestinal resection is often necessary in these cases (Philippe and Chattet, 1950; Tagart, 1953).

Case 4

A 37-year-old mechanic was admitted to hospital with a five-days history of vague and intermittent pains, most pronounced in the epigastrium. For the two days preceding admission he had been confined to bed because of pains and vomiting. On the day of admission his pains had increased in intensity. There had been two loose motions on the day before and a trace of thin faeces and flatus on the day of admission.

On examination he appeared ill, with an anxious expression, lying with his legs drawn up. His tongue was dry; temperature 99.8° F. (37.7° C.), pulse 80. Examination of the abdomen revealed some distension and generalized tenderness, especially around McBurney's point; here rigidity was present. Acute appendicitis with perforation was suspected and immediate operation was decided upon.

At operation the abdomen was opened through a right muscle-splitting incision. As the peritoneum was opened, 0.5 to 0.75 litre of serous fluid gushed out. The appendix was found swollen and red, lying in a subileal position, and was removed in the usual way. On account of the exudate the ileum was inspected after widening the incision, and about 75 cm. from the ileo-caecal valve a torsion of the ileum was found fixed to the root of the mesentery by adhesions around an inflamed Meckel's diverticulum. The gut was distended and bluish-red proximally to this and contracted distally to it. After the adhesions had been cut the volvulus untwisted itself. No resection of intestine was necessary as the gut was viable, and after excision of the diverticulum the abdominal wall was closed without drainage.

The patient's condition deteriorated, and he died 24 hours after the intervention, with the clinical picture of intestinal paralysis and hyperthermia. Necropsy gave no further information.

Intussusception

An introversion of a Meckel's diverticulum may take place, causing obstruction of the ileum (Wessel, 1925-6) or an ileo-ileal intussusception. According to Harkins (1933) this variety of intussusception has several distinguishing features: (a) it occurs in older individuals, (b) a history of previous attacks is more frequent, (c) vomiting is more intense, and (d) the course of the disease is more chronic and there is often a mild attack a day or two before the onset of the major illness. A correct diagnosis of this condition is usually made too late, and an intestinal resection is often required (Benson and Sharpe, 1950) because of irreducibility and gangrene. In infants the condition is very rare (Aitken, 1950).

Case 5

A 12-year-old girl was admitted to hospital on December 31, 1952, with a 16-hours history of sudden pains around the umbilicus, gradually subsiding. Fourteen hours before admission a new bout of pains occurred after a meal. She had no appetite, and her mother gave her an aspirin tablet. There had since been pains of constant character localized to the umbilical region and the right iliac fossa, of varying intensity. She had vomited several times and there had been a normal motion just before admission.

On examination her tongue was dry; temperature 99.4° F. (37.4° C.) and pulse 88. The abdomen was slightly distended, with no visible peristalsis and normal intestinal sounds. Direct tenderness and rebound tenderness were elicited about McBurney's point; Rovsing's sign was positive, and a rectal examination revealed tenderness to the right. Immediate operation was decided

upon, with a preliminary diagnosis of acute appendicitis, even if the symptoms were not typical and she appeared more dehydrated than was to be expected with such a temperature.

At operation the abdomen was opened through a gridiron incision; there were large amounts of serous fluid in the peritoneal cavity. The appendix was in a subcaecal position and showed no signs of inflammation, but a small carcinoid was present at its tip. The appendix was removed. Palpation of the uterus and adnexa revealed nothing abnormal. Inspection of the ileum revealed a 25-cm.-long ileo-ileal intussusception located about 30 cm. from the ileo-caecal valve. The intussusception was reduced, and at its apex an inflamed introverted Meckel's diverticulum was found. The diverticulum was excised without intestinal resection. Convalescence was uneventful. Histological examination showed carcinoid of the appendix and a Meckel's diverticulum with severe inflammatory changes.

Similar cases have been described by Vangsted (1918), Langballe (1918), Holst (1928), Pettersen (1928), Taylor (1947), and others.

Associated Conditions

Owing to the aberrant gastric mucosa a peptic ulcer may be formed in Meckel's diverticulum, especially at the junction between the ileal and gastric mucosa at the base of the diverticulum. Complicating the ulcer, perforation or bleeding may take place; numerous cases of this type have been reported—for example, Nielsen (1933-4), Klindt (1933-4), Aalkjær (1937), Manning and McLaughlin (1947), Jay *et al.* (1950), Hancock (1951), Aitken (1953). In melaena with no known cause an ulcer in a Meckel's diverticulum may thus be the origin of the trouble. Dragstedt (1933) has shown that the heterotopic gastric mucosa secretes hydrochloric acid and pepsin. These secretions become irritating to the ileum, producing spasm in the walls of the ileum and the diverticulum (Sibley, 1944). This author defines a condition called "dyspepsia Meckelii," characterized by pain in the lower right quadrant, the epigastrium, or the periumbilical region.

If the communication with the ileum is obliterated the rare retention cysts may arise. Isolated cases of calculi in a Meckel's diverticulum have been described (Allen and Donaldson, 1945; Palmström, 1950). They give symptoms simulating obstructive appendicitis, and the stones consist of faecal material and bile pigment; they are not visible in radiographs.

Solitary cases of carcinoid in Meckel's diverticulum have been reported (Stewart and Taylor, 1926; Hertzog and Carlsen, 1935; Pautler and Scotti, 1951). Even carcinoma of Meckel's diverticulum has been described (Weir, 1937).

A Meckel's diverticulum may be contained in a hernial sac, usually of a femoral hernia, as originally described by Littre (1700). Littre's hernia is a special variety of the so-called Richter's hernia. Inflammation of a Littre's hernia often takes place, and it becomes irreducible. The characteristic complication is incarceration which may go on to abscess and fistula formation (Mair, 1948).

A diagnosis of Meckel's diverticulum is seldom arrived at pre-operatively. Solitary cases of radiographic demonstration of a Meckel's diverticulum have been reported (Aalkjær, 1937; Rousseau and Martin, 1943; Butler *et al.*, 1950), but in the acute cases this method is not to be recommended.

Treatment

In cases of intestinal obstruction, perforation, or diverticulitis the diverticulum should be removed. Opinion on this is unanimous. Removal can often be performed in the same way as an appendectomy. If the base is thick (and the gastric mucosa is often at the base, as mentioned above) a large wedge-shaped excision should be performed, followed by repair. If this is not possible a bowel resection is required, and in our department we prefer a side-to-side anastomosis.

Many authors state that an incidentally found Meckel's diverticulum should be left alone. Sibley (1944), however, recommends the earliest possible removal of any Meckel's diverticulum. Considering the grave abdominal complica-

tions with a high mortality (about 15% according to Wagner *et al.*, 1950) it can provoke, any incidentally found Meckel's diverticulum should be removed if this procedure does not materially increase the operative risk.

Summary

The complications of Meckel's diverticulum which call for emergency surgery are infection, obstruction, intussusception, volvulus, and haemorrhage. The difficulties in diagnosis have been illustrated by five cases.

The incidentally found Meckel's diverticulum should be removed if this procedure does not materially increase the operative risk.

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In 1953 the accident section of the London Ambulance Service dealt with 90,896 emergency calls—compared with 87,691 in 1952 and 87,012 in 1951. Thirty-nine ambulances were in commission, operating from the 18 accident ambulance stations; they covered 457,514 miles, an increase of 15,246 over 1952. Fridays and Saturdays are still the busiest days of the week, with averages of 267 and 266 calls, and Sunday remains the quietest day with 188 calls. Unlike 1952, when most calls were received in December, in 1953 the highest average number of calls were received in June—280 calls a day—and May—269 calls a day. These figures reflect the record numbers reached on Coronation Day, when 650 patients were removed by the London Ambulance Service. The general section of the Service, which deals with the non-urgent removal of sick people, carried out 428,946 journeys in 1953, conveying 721,334 patients a distance of 3,625,430 miles. In 1951 550,621 patients were carried, and in 1952 660,206. The majority of these journeys were for the conveyance of out-patient cases to and from hospitals, clinics, etc.

COMPARISON OF SODIUM AND PROCAINE PENICILLIN IN TREATMENT OF EXPERIMENTAL STAPHYLOCOCCAL INFECTION IN MICE

BY

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It is remarkable that there is still a division of opinion regarding the administration of penicillin in the treatment of infections. It has often been maintained that the therapeutic benefits of penicillin depend on the time during which there is an amount of penicillin in the blood stream sufficient to kill or inhibit the growth of the infecting organism. This possibility was recognized in the early days of penicillin therapy, and the continuous administration of penicillin by intramuscular drip rather than by intermittent intramuscular injection was advocated so that a bacteriostatic level of penicillin in the blood could be maintained throughout treatment. It was, however, pointed out by Hudson *et al.* (1946) that, for the same amount of penicillin over a 24-hour period, the intermittent method of administration gave a much higher average level of penicillin in the blood than the continuous method, and they also contended that intermittent therapy would be more effective in that the high peaks of penicillin obtained in the blood after each injection would enable penetration of penicillin into the foci of infection. The intramuscular drip method was soon abandoned, largely because of technical difficulties in its application, with the result that no clear-cut comparison could be made of its value relative to the more widely used intermittent method.

The question has again been raised with the introduction of depot preparations of penicillin, which have the advantage over sodium penicillin of prolonging the absorption of penicillin from the site of injection, so that effective concentrations are maintained in the blood stream for a much longer time. It is on these grounds that the advocates of the new preparations recommend their use, but it appears that little or no evidence has been adduced to show that they are better than aqueous solutions of sodium penicillin in the treatment of infections. The experiments described here have been designed to provide such evidence so far as it applies to an experimental infection which has been used by Selbie and Simon (1952) in their investigation on the virulence of *Staph. pyogenes* to mice.

Material and Methods

The two strains of *Staph. pyogenes* used for these experiments have been described by Selbie and Simon (1952). Strain No. 221 was used for five experiments, but had to be abandoned because of a fall in virulence. Fourteen experiments were done with Strain No. 144. At the time of the experiments the growth of the strains *in vitro* was inhibited by about 0.04 unit of penicillin per ml.

In each experiment four groups of six mice of about 30 g. body weight were inoculated intramuscularly in the left thigh with 0.2 ml. of an 18-hour culture of *Staph. pyogenes* in tryptic digest broth. The first group was left untreated, and the succeeding groups were treated with an aqueous solution of the sodium salt of penicillin G, a suspension of procaine penicillin G in arachis oil containing 2% aluminium stearate ("avloprocil"), and an aqueous suspension of procaine penicillin G ("distaquaine G"). Each

*Professor F. R. Selbie died on February 22.