of the patients were under his care. I would like to express my gratitude for his advice and encouragement. My thanks are due also to other members of the staff of the National Heart Hospital for their assistance in the selection and observation of cases.

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APPENDICITIS IN THE COURSE OF MEASLES

BY

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Having personally seen seven cases of appendicitis occurring during the course of measles in the space of 18 months, I searched for any report on this matter in a British journal. No such report was found, except for a most interesting letter from Dr. Leak (1935). Several papers on this subject have been published in the German and American literature. In several standard works, gastro-intestinal lesions are described. Nothnagel (1902) discusses the pathology of individual organs as affected in measles as follows. "Although no anatomic changes are demonstrable in the intestines, the occurrence of frequent evacuations during an attack of measles bears a close relation to the underlying infectious process. Diarrhoea may appear as an early symptom, ushering in the enanthemic stage or even preceding it, but may also persist until after the conclusion of the eruptive stage. . . . The diarrhoea is ascribed to the specific inflammation of the intestinal mucous membrane, to the eruptive process by which it is affected."

In *Modern Practice in Infectious Fevers* (1951) lesions of the gastro-intestinal tract are described thus: "Inflammatory catarrh with desquamative changes extends the whole length of the digestive tract. Koplik spots may appear anywhere, including the vermiform appendix, which is often swollen and congested and may undergo suppurative or necrotic changes. Multinucleated giant cells may be found similar to those in the spleen, tonsils, and lymph glands."

Harries and Mitman (1951) also make reference: "Some observers have claimed that tenderness over the appendix region or a definite attack of appendicular colic is not infrequent during the prodromal stage of measles, and would correlate this occurrence with the demonstration of giant cells in the mucosa of the appendix. Laparotomy in such cases has revealed an appendix normal to the naked eye or showing catarrhal

changes only. On the other hand, acute perforative appendicitis has occurred, probably as a fortuitous complication."

A brief description of seven cases is given below.

Case Reports

Case 1.—Male aged 4 years. *History*:—Two days before admission the child developed severe right-sided abdominal pain of colicky nature. He did not eat his evening meal. The attacks were spasmodic. He still had pain the next day. On the day of admission he awoke screaming with right-sided pain, and occasionally drew up his legs. A loose stool was passed. There were no urinary symptoms. *Examination*:—Tenderness in right iliac fossa. P.R., marked tenderness on right side; T. 99.2 (37.3° C.), P. 120, R. 24. *Operation*:—Gridiron incision. Peritoneum healthy. Acutely inflamed pelvic appendix found and removed. Rash appeared four days after operation.

Case 2.—Male aged 11 years. *History*:—Four days before admission, developed cough and sore throat. Twenty-four hours before admission, measles rash appeared. Eight hours before admission, he awakened with colicky pain localized to the right iliac fossa; vomited once and passed a stool. Further pain two hours later. *Examination*:—Definite tenderness in right iliac fossa—localized. P.R. tender on the right; T. 98.6 (37° C.), P. 80, R. 22. *Operation*:—Gridiron incision; appendix showed slight redness. Rash appeared one day before admission.

Case 3.—Male aged 5 years. *History*:—Twelve hours before admission, while at school, he developed right-sided abdominal pain, not severe enough to make him leave. Pain became worse on way home and he vomited. *Examination*:—Tender in both iliac fossae. P.R., tender on both sides; T. 98 (36.7° C.), P. 112, R. 26. *Operation*:—Gridiron incision. Apparently healthy appendix—no fluid. One small gland felt. Appendix removed. Rash appeared four days after operation.

Case 4.—Male aged 5 years. *History*:—Forty-eight hours before admission, developed pain in right side and across lower abdomen; colicky. Vomited twice. *Examination*:—Tender in right iliac fossa with muscle-guarding. P.R., tender. *Operation*:—Gridiron incision. Slightly inflamed appendix removed. T. 99.4 (37.4° C.), P. 96, R. 20. Rash appeared four days later.

Case 5.—Male aged 4 years. *History*:—Four days before admission, developed measles. Twelve hours before admission, onset of acute abdominal pain. Pain recurred eight hours later and he had a third spasm just before admission. *Examination*:—Well-marked measles rash. Abdomen held rigid. Definite tenderness in right iliac fossa. *Operation*:—Gridiron incision. Perforated appendix with small quantity of purulent fluid in peritoneal cavity. Appendix removed. Rash appeared four days before admission.

Case 6.—Male aged 2½ years. *History*:—Three days before admission, complained of abdominal pain and vomited. Vaguely "out of sorts" for a day or two before this. Next day pain localized to right iliac fossa. Vomited three times. Fevered. Passed one loose stool. Observed overnight at Children's Hospital. Measles rash next morning. Transferred to City Hospital. Abdominal symptoms attributed to measles. Very definite signs of acute appendicitis, but operation postponed again because of the measles. T. 102.6 (39.2° C.), P. 160, R. 30. By the next day the child had obvious peritonitis and a mass could be felt high in the right iliac fossa. *Operation*:—Gridiron incision. Purulent fluid in peritoneal cavity. Retrocaecal appendix with early abscess formation. Appendix removed and peritoneum drained. Rash in this case appeared two days before operation. The child developed pneumonia and died six days after operation.

Case 7.—Female aged 5 years 11 months. *History*:—Abdominal pain four days before admission. Slight pain present next day, when child vomited on three occasions.

Two days before admission, pain disappeared, but recurred on the day she came into hospital. Mainly para-umbilical. *Examination*.—Tender on deep palpation in the right iliac fossa. P.R., very tender. *Operation*.—Right paramedian incision. Apparently normal appendix found and removed. Ileocaecal mesenteric adenitis present. Rash appeared two days after operation.

Pathology

Davidsohn and Mora (1932) drew attention to a type of giant multinucleated cell found in appendices removed during the prodromal stage of measles. This type of cell had been previously reported by Warthin (1931) in tonsils removed at the same stage of the disease. Hudson and Krakower (1936) quote Finkeldey (1931) as describing them originally. Others who found them in the appendix include Hathaway (1935) and Avancini (1948).

It was thought by Davidsohn and Mora (1932) that the abdominal pain was due to changes in the lymphoid tissues in the gastro-intestinal tract. This reaction was thought to be directly attributable to measles. In some appendices many of these multinucleated cells were found, especially in those not showing much naked-eye evidence of inflammatory change. In others showing obvious inflammatory change very few of these cells were found, although they were present in regional lymph nodes. One theory to account for this, put forward by Davidsohn and Mora, was that the swelling of the mucosa of the appendix prepared the way for secondary invaders. By the time these true inflammatory changes had occurred the giant multinucleated-cell reaction had passed. A parallel can be found in tonsils removed during the prodromal stage of measles.

In the present series only one appendix (Case 4) was sectioned. At operation the appendix was thought to be slightly inflamed. The histological report, by Professor Young, was:

"The appendix had been opened from base to tip by the surgeon before fixation, and it was bisected longitudinally for microscopical examination. No notable abnormality was visible to the naked eye.

"Microscopically, the mucosal lymph follicles showed a peculiar hyperplasia of their reticulum cells, culminating in the formation of numerous giant cells, the largest of which were crammed with 100 or more small vesicular nuclei, while smaller forms contained as few as two or three relatively large nuclei with prominent nucleoli; in all cases, the cytoplasm was extremely scanty. Chromatin fragments resulting from karyorrhexis were often observed in the germinal centres, but there was no focal necrosis, and the general architecture of the lymphoid tissue was remarkably well preserved. No inclusion bodies were identifiable. The muscularis was normal in appearance apart from the presence of a very few perivascular round cells, but the serous coat showed a minor degree of fibrous thickening, with increased vascularity. There was no evidence of pyogenic inflammation.

"*Comment*: The changes in the lymphoid tissue of the appendix conform in every essential respect to those described by Warthin (1931) in the tonsil in the prodromal stage of measles."

The findings at operation in the seven cases reported were that two appendices were normal, three were acutely inflamed, and two were perforated.

Koch (1937) described two cases, in both of which the appendices were acutely inflamed. Angel and Kizinski (1938) described three cases and reviewed the literature. Their three cases all showed acute inflammation at operation. With the seven cases here reported, I have found 49 described in the literature, mostly in the United States of America, with a few contributed from Germany. Of these, 26 showed subacute or acute inflammatory changes, 12 showed abscess formation, 4 were gangrenous, 5 were perforated with pus in the peritoneal cavity, and 2 showed no naked-eye inflammation. The histology of one of these is described above.

Onset with Relation to the Rash

Hudson and Krakower, reviewing the literature, found 40 cases. Of these, 15 developed the symptoms during the pro-

drodromal stage, 12 during the period of eruption, and 13 in the immediate convalescent stage. Koch's two cases occurred during the eruptive period. In the present series, four occurred during the prodromal stage and three during the eruptive period. Thus, of 49 cases, 19 developed the symptoms during the prodromal stage, 17 during the eruptive period, and 13 in the immediate convalescent period.

Discussion

While it is admitted that appendicitis and measles are both very common diseases in childhood, it is felt that the occurrence of the two together is not fortuitous. For many years appendicular colic has been a known concomitant of measles. Several workers have shown that it is dangerous to assume that the abdominal pain is part and parcel of measles. Most of the appendices removed showed acute inflammatory processes, and of the 49 reported 26 showed acute inflammatory change and 21 had gone on to the gangrenous stage and had ruptured, causing peritonitis or local abscess formation.

The case histories here reported show that abdominal symptoms had been present from 12 to 72 hours before the rash became obvious. All of them were most suggestive of acute appendicitis, and on clinical examination the findings were also in favour of this condition.

The pathology has been briefly outlined, and also the relationship of the abdominal condition to the stage of measles. In view of the acute nature of the appendicitis in this condition, and the speed with which abscess and/or perforation can occur, any sign or symptom of appendicitis in the course of measles should not be lightly dismissed. On the contrary, if, during the course of measles, abdominal symptoms should be equivocal, repeated examinations should be carried out. Angel and Kizinski (1938) advocate this, and Davidsohn and Mora (1932) are of the same opinion. The latter also quote Trepel as emphasizing that appendicitis occurring during the prodromal stage is a more acute and fulminating process. Case 6 had operation postponed as measles developed. When this case was discussed with surgical colleagues, in retrospect, their feeling was that, had measles not developed the day after admission, operation would have been carried out then. If operation had been carried out shortly after admission instead of 72 hours later, perhaps the inflammatory process would not have advanced to local abscess formation with peritonitis.

It is felt that measles probably initiates subsequent infection of the appendix. Thenebe *et al.* (1933) suggest that there may be ischaemia of the appendix, due to pressure of the enlarged lymphoid tissue in the submucosa and, for the same reason, interference with the flow of lymph. This leads to a local or a more extensive area of necrosis. This in turn is followed by bacterial invasion, probably from the ever-present intestinal flora.

From the above discussion and for the reasons given, it is strongly recommended that any child with measles in whom a diagnosis of acute appendicitis is made should be operated upon forthwith. Where the signs are less definite repeated examination at short intervals should be carried out.

Summary

Seven cases of appendicitis occurring in the course of measles are described, with one death.

A brief review of the literature is given.

The pathology of one case is given in detail, showing the typical findings during the prodromal stage of measles. This consists in an intense lymphoid reaction and the presence of multinucleated cells and a type of giant cell. It is confirmed that the presence of these cells is pathognomonic of measles in the prodromal stage.

During the course of measles, symptoms of acute appendicitis warrant immediate operation.

I would like to express my thanks to Professor John Craig for his help and advice and to Professor Young for the histological report.

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THE LARYNGEAL MICROPHONE AS AN AID TO TREATMENT OF BULBAR POLIOMYELITIS

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In the treatment of bulbar poliomyelitis the prime requirement is the maintenance of a clear airway. Failure to keep the airway free from obstruction results in anoxia and hypercapnia. McDowell and Wolff (1953) have advocated early tracheotomy as a prophylactic measure in bulbo-spinal cases. Galloway (1947) recommends tracheotomy in bulbo-spinal cases, and also in other types of the disease whenever there is difficulty in maintaining a clear airway. The frequency with which tracheotomy may be needed should be much reduced if the technique of detecting and removing obstruction is improved. Ritchie Russell (1952) has stressed the need for a continuous watch over the patient to detect obstruction at the earliest possible moment. If this can be done, and adequate postural drainage in the prone position is used, most cases of bulbar poliomyelitis uncomplicated by failure of respiratory muscles can be kept fully ventilated without tracheotomy.

The first indications of obstruction are not, however, easily detected even by experienced nurses, especially if there is much other noise in the ward. In order to eliminate this source of danger, an instrument has been developed to amplify respiratory sounds so that the slightest obstruction is immediately apparent. It has been tried out in two epidemics and has proved to be of the greatest value.

The instrument, as constructed here, consists of a standard pattern of U.S. Air Force laryngeal microphone,* together with an amplifier and loudspeaker. Details of the construction of two models, one mains-operated and the other battery-operated, are given below.

The method of using both instruments is the same. The microphone is placed over the patient's larynx and held in place by an elastic band. If the laryngeal position is inaccessible, as may be the case when the patient is prone, the microphone may be placed on the back of the neck, over the temple, or even on the occiput, when the sounds will be picked up by bone conduction.

*Type ZA.19734, readily obtainable from many shops dealing in radio equipment, and advertised in *Wireless World*.

Light pressure only is required, just enough to prevent displacement by the patient's movements. The volume is then adjusted until the intermittent rushing sound produced by normal unobstructed respiration is just audible without being obtrusive. Under these conditions the sound caused by obstruction of the airway is loud enough to draw attention from the far end of the ward. The bubbling sound, accompanied by loud rhonchi so produced, is quite unmistakable, and quite distinct from the more clattering or clicking noise produced by swallowing.

Construction of the Instruments

The circuit diagram of the mains-operated instrument is given in Fig. 1, and of the battery model in Fig. 2.

FIG. 1.—Circuit of mains-operated unit. R_1 , 100 K Ω . R_2 , 1,500 Ω . R_3 , 250 K Ω . R_4 , 100 K Ω . R_5 , 100 K Ω . R_6 , 1,500 Ω . R_7 , 1 M Ω . R_8 , 1 M Ω . R_9 , 500 K Ω . R_{10} , 100 K Ω . R_{11} , 100 K Ω . R_{12} , 500 K Ω . R_{13} , 500 K Ω . R_{14} , 500 K Ω . R_{15} , 50 K Ω . T_1 , Microphone input transformer, 100:1. T_2 , Speaker output transformer. T_3 , 300-0-300 V, 5 V. 6.3 V. C_1 , 0.1 μ f. C_2 , 0.1 μ f. C_3 , 0.1 μ f. C_4 , 0.1 μ f. C_5 , 0.001 μ f. C_6 , 8 μ f. C_7 , 8 μ f. C_8 , 0.01 μ f. V_1 , EF 36. V_2 , ECC 35. V_3 , 6V6. V_4 , 6V6. V_5 , 524. P_1 , 600 K Ω . L_1 , 5H, 100 mA. L_2 , 100H, 5 mA.

FIG. 2.—Circuit of battery-operated unit. R_1 , 30 K Ω . R_2 , 1 M Ω . R_3 , 500 K Ω volume control. T_1 , Microphone input transformer, 100:1. T_2 , Speaker output transformer. V_1 , DF 92 (or 1L4). V_2 , DL 92 (or 3S4). C_1 , 0.002 μ f. C_2 , 0.01 μ f.

As will be seen, the mains amplifier is a three-stage type, with push-pull output to an 8-in. (20 cm.) loudspeaker. This provides a maximum output volume much greater than is normally needed. The highest and lowest notes are attenuated, as the required diagnostic sounds are mainly in the middle frequency range, from 100 to 2,000 cycles approxi-