or blood pressure. We tested this on ourselves below ground in "dull air," and in one section which had been abandoned on account of bad ventilation. The differences noted were: slight slowing of the respiration (16 as compared with 18 above ground), and slight increase in pulse rate (84 and 72); it was not possible to take a blood pressure reading there as the light was so poor.

The large amount of CO₂ in mine air requires some explanation. There is, of course, no consumption of CO₂ underground; on the contrary, it is being produced constantly. The amount present is only to a very slight degree due to respiration of men and ponies and the burning of oil lamps. It is almost entirely due to the oxidization of wood and of the exposed surfaces of the coal, together with the gas actually liberated from the coal itself.

The other obvious abnormal factor in the conditions of work underground, in addition to the composition of the inspired air, is the absence of daylight. It is evident that in winter, at least, many miners seldom see sunlight or even daylight. The importance of this is only now being fully recognized, but at present we are not prepared to assess its significance in the subject under inquiry. We have, however, been able to trace a progressive thickening of the arteries with the length of time during which the men worked underground; this is shown in Table VIII.

TABLE VIII.

Duration of Work Underground.	No. of Men.	Condition of Arteries.		
		A.	B.	C.
(1) Under 1 year	44	21	23	0
(2) 1-5 years... ..	111	6	96	9
(3) 5-10 years	108	7	79	22
(4) 10-20 years	112	6	69	37
(5) 20-30 years	71	4	38	29
(6) 30-40 years	39	0	10	29
(7) Over 40 years	15	0	3	12
Total	500	44	318	118

It is seen that of 44 men who had worked below ground one year or less, no fewer than 21 had normal arteries—that is, 48 per cent.; and those were not only boys, but included men up to 30 years of age. In no other grouping of the cases is it possible to get such a large percentage of normal arteries. It is also noticeable that there is a distinct increase in the amount of thickening of the arteries with the duration of occupation underground.

From this last table it seems evident that work below ground, under the conditions of ventilation shown to prevail, has a definite relation to the prevalence of arterio-sclerosis in coal miners. We believe that it is this arterio-sclerosis, with its subsequent results on general nutrition, which accounts for the increased mortality of coal miners after the age of 55. For although statistics may not show conclusively that miners suffer from diseases of the circulatory system more than men in other occupations, yet it is only to be expected that such an insidious pathological condition as arterio-sclerosis will in many cases fail to be recognized as the initial cause of death.

It has been our experience to meet with many miners who, while not complaining specially of any circulatory disturbances, have the physical appearance, while still on the right side of 60, of having summed up their threescore years and ten; and in many cases we have seen these men dying at or about the age of 60 with all the symptoms of vascular degeneration.

SUMMARY.

1. There is an unexplained difference in the mortality rate of coal miners as compared with other occupied males.

2. The results of the consecutive examination of the circulatory system of 500 coal miners are analysed.

3. It is shown that among coal miners of all ages there is an extraordinary prevalence of thickened arteries; the thickening is confined to the intima in the specimens examined.

4. There is no associated rise in blood pressure.

5. The only significant constant factors are (a) the inhalation of air of altered composition, especially the CO₂ content; and (b) the absence of daylight.

6. It is suggested that the arterio-sclerosis shown to exist in coal miners is the explanation of the peculiarity in their mortality rate.

DIFFUSE PNEUMOCOCCAL PERITONITIS IN A BOY:

POST-OPERATIVE PARALYTIC ILEUS TREATED BY ANTI-GAS-
GANGRENE SERUM: EMPYEMA: RECOVERY.

BY

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SINCE 1926, when Williams¹ drew attention to the uses of anti-gas-gangrene serum in peritonitis and intestinal obstruction, many encouraging results have been described following the use of the serum in such cases. Molesworth² rightly sounds a note of caution in accepting such enthusiastic clinical reports of a comparatively new form of treatment. I venture to publish the following account of a case of diffuse pneumococcal peritonitis where anti-gas-gangrene serum had a beneficial effect and the patient recovered from a disease in which the mortality is admittedly very high.

A boy, aged 15 years, who had previously been in good health and had never suffered from any serious illness, was admitted to hospital on May 25th, 1929, with acute abdominal symptoms. He had become suddenly ill five days previously with severe abdominal pain and vomiting. There was no rigor. The pain was spasmodic, increased gradually in severity, and was felt most acutely in the lower abdomen, especially in the right side. From the commencement of the attack the bowels were constipated. No frequency of micturition was noted, but the boy at times complained of pain during the act. At no time did the patient have any cough or chest symptoms. (For the above particulars I am indebted to Dr. W. W. Turner, Lochinver, who recommended the case.)

On admission the patient was in a critical condition. He was very thin, the face was pinched, the expression anxious. The lips and finger-tips showed some cyanosis. The temperature was 102° F., the pulse rate 126, irregular and feeble; the respirations were 24 per minute. The tongue was dry and furred, and the breath was foul. There was no herpes labialis. He complained of severe and continuous abdominal pain, most marked in the umbilical and right iliac regions. There was frequent vomiting of offensive brown watery matter, which was very acid in reaction. The abdomen was moderately distended, immobile, and intensely rigid all over. Cutaneous hyperaesthesia and tenderness were most marked in the umbilical region and the right lower quadrant. The percussion note was tympanitic except in the flanks, where some dullness was present. There was no cough, and nothing abnormal could be detected on examination of the chest. The right tonsil was moderately enlarged and appeared to be slightly inflamed.

Operation.—As a preliminary morphine 1/6 grain and atropine 1/100 grain were given. Anaesthesia was induced with gas and oxygen, and followed by open ether. The abdomen was opened by a right paramedian incision. Much thin yellowish pus at once escaped and was seen oozing from all directions. The pus had a peculiar musty odour, and contained small flakes of lymph. There were no signs of adhesions even in an early stage of formation, the infection being diffuse. The peritonitis was, however, distinctly more intense in the right infra-colic compartment. The caecum, appendix, and subperitoneal tissues were oedematous and injected. The small gut was of a dull red colour, had lost its gloss, and appeared lifeless. The glands at the root of the mesentery were enlarged and inflamed. The peritoneal cavity having been cleansed as much as possible, and the appendix removed, a drain was placed in the pouch of Douglas through a separate stab wound in the mid-line. The original wound was closed, with a small drain in the lower angle.

Pathological Report.—The direct preparations showed many pus cells and numerous Gram-positive diplococci. Inoculated media yielded pure growths of a pneumococcus.

Progress.—Rectal salines and glucose (2 per cent.) were given four-hourly, and on the following day the condition of the boy had improved; temperature 99.4° F., pulse 80–100. On the afternoon of May 27th, about thirty-six hours after operation, he was uncomfortable and restless, and became rapidly worse towards evening. Vomiting recommenced, the abdomen became distended, and no flatus was passed. Enemata were ineffectual. The pulse rate rose to 130; the extremities were cold. It was obvious that a paralytic ileus was present. At 6.45 p.m. 10 c.cm. of anti-gas-gangrene serum "W." (Wellcome) was given intramuscularly. An hour later a little flatus had been passed and the patient was more comfortable. At 9 p.m. 10 c.cm. of serum was given. Shortly afterwards flatus was passed freely and he was much relieved. The vomiting ceased, and during the night he had some natural sleep. The next day the temperature was 99° F., pulse 100. At 10.45 a.m. he was given 12.5 c.cm. of serum. Soon afterwards the bowels moved freely, the motions being dark and extremely offensive. At 6.30 p.m. he was given another 12.5 c.cm. of serum. During the next few days the bowels continued to act four to six times in the twenty-four hours. On June 6th a dose of castor oil was given and the motions became normal.

The general condition improved steadily, although the temperature rose each night to 99° or 100° F. The chest was examined on several occasions without detecting any abnormality. On June 16th he suddenly had a sharp spell of coughing and the respirations rose to 36. A small area of dullness was discovered at the base of the left lung. As the boy was comparatively well and had little discomfort it was decided to wait in order to allow the abscess to localize. However, on June 20th he coughed up several ounces of pure pus. The physical signs in the chest cleared, the temperature and pulse dropped to normal, and he made good progress towards recovery.

On July 15th the temperature again rose, and it was evident that a large collection of pus was forming in the left chest. It was noticeable that there was no cough, and although the temperature gradually rose to 103° F., he had practically no discomfort. On July 20th, under general anaesthesia (gas and oxygen), a portion of the ninth rib was resected in the posterior axillary line, the cavity cleansed, and drainage instituted by

the "closed" method. Drainage of typical pneumococcal pus continued for some days. At the end of a week the discharge had practically ceased; the wound was dressed for the first time and the sutures and tube were removed. Healing took place rapidly and without complication.

The patient subsequently made an uninterrupted recovery.

Summary.

The points of interest in this case may be summarized as follows:

1. At the outset the history did not suggest a pneumococcal peritonitis. There was no rigor at the commencement of the acute illness, no diarrhoea occurred, neither was there any herpes labialis. Exact pre-operative diagnosis was not possible.

2. As no demonstrable path of infection existed, the condition appeared to be an "idiopathic" type of the disease, although Fraser³ makes it clear that primary pneumococcal peritonitis can only occur in the female. In the light of the subsequent history, however, the condition must be regarded as a septicaemia with a small concealed focus in the lung as the primary focus. Barrington-Ward⁴ describes a case of pneumococcal peritonitis where a very small hidden empyema, unsuspected during life, was discovered post mortem.

3. Although the peritonitis was diffuse, it was clearly seen at operation that the infection was most intense in the ileo-caecal region.

4. The administration of anti-gas-gangrene serum in its concentrated form proved beneficial when the establishment of a paralytic ileus had rendered the condition apparently hopeless.

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- ² Molesworth: *British Medical Journal*, August 24, 1929, p. 344.
- ³ Fraser: *Surgery of Childhood*, vol. 2, p. 803.
- ⁴ Barrington-Ward: *Abdominal Surgery of Children*, p. 63.

GRADENIGO'S SYNDROME FOLLOWED BY COMPLETE RECOVERY.

BY

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GRADENIGO'S syndrome has attracted a considerable amount of attention in recent years, and the following details of a rather unusual case may therefore be worthy of record.

A public school boy, aged 16, had an acute attack of otitis media on March 13th. There was a history of discharge from the right ear for a short period, after influenza five years previously. The present attack was preceded by a post-nasal infection on March 9th.

The ear was discharging freely when it was first seen. The temperature persisted in the neighbourhood of 99° F. until March 28th, when it rose to 101° F. There was slight tenderness over the mastoid region, and a Schwartz operation was performed on that day; this revealed a very cellular mastoid, with an extensive cell system passing backward behind the lateral sinus and necessitating a backward continuation of the incision. There was also an infected cell system, which dipped deeply into the back of the petrous bone in front of the sinus. These cell systems were opened up and the whole tip of the mastoid was removed. All the cells contained pus, from which a short-chain non-haemolytic streptococcus was recovered.

Although the wound appeared perfectly healthy and the discharge rapidly became mucoid, the boy continued to have a temperature around 99° F. No cause for this pyrexia could be found in the ear, chest, or elsewhere. Immediately before the operation and for a fortnight afterwards he complained of pain, neuralgic in character, above and below the right eye. There was no headache.

On April 9th he complained of a fleeting diplopia, and on the following day there was obvious weakness of the external rectus of the right eye; by April 13th paralysis was complete. There was no further neuralgia after this date. The temperature became normal on April 17th, and remained so.

He was discharged home on May 2nd with the mastoid wound healed and the membrana tympani intact. He could then easily hear a 32 double vibrations fork. Some recovery of the external rectus of the right eye was just detectable.

On May 13th he was examined for the diplopia, and it was found that he had an internal squint with almost complete

paralysis of the right external rectus and uncrossed diplopia, most marked on looking to the right. There was hardly any vertical displacement of the images. Vision was 6/6 in both eyes, with a +2 cylinder (95 degrees) in the right and a +2.25 cylinder (90 degrees) in the left. In other words, after correction of the hypermetropic astigmatism present, he had full vision with each eye. The fundi and media were normal. The father stated that the eye was "not so much in the corner as it was at first." On looking directly ahead at a small light placed at 6 metres distance, with a Maddox rod before the defective eye, there was between 30 and 40 degrees of measurable esophoria. He could not obtain any fusion of the two images.

Paralysed eye muscles differ from those in other situations in that the defective muscle cannot be kept at rest. The eye muscle is kept constantly but partially moving, even if the eye is covered, by the conjugate movements of the two eyes. This very considerably aids its recovery if the nerve is not permanently destroyed, especially in a situation where massage and faradism cannot be applied. This boy was treated by an expert masseuse twice a week, between May 21st and July 2nd, with ionization with the continuous galvanic current for five to seven minutes; the pads were soaked in saline, and applied, one between the second and fourth cervical vertebrae and the other directly over the outer conjunctiva, which had been previously anaesthetized by 1 per cent. cocaine solution. The patient tolerated this treatment quite well, and it was followed by interrupted galvanism in the hope of stimulating the external rectus muscle fibres. He wore a shade to free him from the disabling diplopia.

His progress was as follows.

May 27th: Hardly any visible squint; 18 degrees of esophoria; single vision with prism, but not without it.

June 11th: There was 12 degrees of esophoria. The first thing in the morning the patient did not have double vision, but it came on by breakfast time. It was decided to try to abandon the shade in the earlier part of the day.

June 24th: The esophoria was now only 3 degrees, and the patient left off his shade. Fusion was obtained without any prism.

July 8th: No measurable esophoria was detectable, and there was good binocular vision. The abducent nerve, therefore, took about three months to recover.

We publish this case chiefly for the interest of the complete report of the recovery, which in such cases has not always been fully recorded. It is also noteworthy that the syndrome was associated with an exceptionally cellular mastoid. The syndrome is not of the complete Gradenigo type in that the boy at no stage suffered from headache.