freed of the meningococcus, the opportunity was taken of determining the effect of the air of the chamber upon the meningococci in his naso-pharynx. His naso-pharynx having been swabbed, he put on a mackintosh and entered the chamber where the air was saturated with the vapour of a 2 per cent. chloramine spray and gave a dry and wet bulb reading of 78° F. He stayed in the chamber for six minutes, with a staphylococcus plate exposed near him, and during the whole of this time vigorously inhaled the air through his nostrils. After leaving the chamber his naso-pharynx was very thoroughly reswabbed.

The result was as follows: Before entering the chamber his naso-pharynx gave a profuse growth of meningococcus colonies. After leaving the chamber his naso-pharyngeal secretion gave no growth whatever of meningococcus. Only a few colonies of any kind grew; and they were colonies of streptococcus.

The agar plate sown with staphylococcus and exposed to the air of the chamber during his sojourn there, showed a 99 per cent. reduction of this micro-organism as compared with a control plate.

Two days later the naso-pharyngeal secretion of this case was re-examined and the meningococcus was found to be again present. After fifteen minutes' sojourn in the chamber, however, his naso-pharyngeal secretion was found to be again free of it. After a further interval of two days, examination of the naso-pharyngeal secretion failed to show the meningococcus.

CASE II.

A staff sergeant who was also carrying the meningococcus in his naso-pharynx was exposed in a similar way to the air of the chamber saturated with the vapour of a 2 per cent. solution of chloramine. He was able to stay in the chamber for twenty minutes, and could have stayed longer had it been thought advisable. While he was in the room, four agar plates sown with staphylococcus were exposed. The first two plates were closed and removed after ten minutes' exposure, the others remained open for the whole time that he was in the chamber.

The result of this test was as follows: Before entering the chamber, the naso-pharynx of the staff sergeant yielded fairly numerous colonies of the meningococcus; but this organism was not so abundant as in Case I. After leaving the chamber, no colonies of meningococcus could be grown from his naso-pharyngeal secretion which, however, showed a fair number of colonies of other organisms.

All four plates sown with staphylococcus that were exposed to the air while he was in the chamber gave no growth. As two of these plates had only been exposed for ten minutes, it is clear that the staphylococcus had been destroyed within that time.

On the following day the naso-pharynx of this case was re-examined and meningococcus found to be absent. The treatment, however, is being continued.

Conclusions.

These preliminary observations furnish the following answers to the three questions formulated at the beginning of the paper:

1. The air of an ordinary room, when brought to the point of saturation by means of a steam spray containing 2 per cent. of chloramine, acquires pronounced bactericidal properties for *Staphylococcus epidermidis*.

2. Such air can be tolerated by human beings for a period varying from six to twenty minutes without marked discomfort and without harm.

3. When inhaled through the nose, this air succeeds temporarily in destroying the meningococcus in the naso-pharynx of carriers. Its sphere of usefulness in this and other respects is being more closely investigated.

In view of the simplicity and convenience of the method and its obvious suitability for the purpose of dealing with a large number of carriers at a time, the above results are encouraging. That such a mode of treating meningococcus carriers has prospects of success may also be inferred from the statement of E. Kuster (*Deut. med. Woch.*, September 9th, 1915) that during an outbreak of cerebro-spinal fever at Cologne early in 1915, meningococcus carriers were freed of that micro-organism by exposing them in an "inhalatorium" to an atmosphere impregnated with Sano's fluid, the active principle of which, like chloramine, is a compound of hypochlorous acid.

D

PARALYSIS OF THE INTESTINE AFTER RESECTION FOR GUNSHOT INJURIES.

BY

CAPTAIN OWEN RICHARDS, M.Ch., F.R.C.S., R.A.M.C.,
SURGEON TO KASR-EL-AINY HOSPITAL, CAIRO,

AND

CAPTAIN JOHN FRASER, M.D., M.Ch., F.R.C.S.E.,
R.A.M.C.,

ASSISTANT SURGEON, ROYAL HOSPITAL FOR SICK CHILDREN,
EDINBURGH:

With Note by

COLONEL CUTHBERT WALLACE, C.M.G., A.M.S.,
CONSULTING SURGEON, B.E.F.

This serious complication seems to occur only in the small intestine. It consists in the paralysis and distension of the gut immediately above the junction which is made after removal of an injured coil. The distension ends sharply at this point, and the bowel below remains in a contracted and apparently healthy state. If unrelieved, the condition is rapidly fatal in the same way as any other form of acute obstruction. It may occur either in cases operated on after a considerable interval, or in those which have been dealt with within a few hours.

In cases in which operation has been delayed it is easier to understand. It is now recognized that injury to the small intestine is not as a rule accompanied by any considerable escape of contents, and such escape as does occur is not progressive, as it is in the duodenum or large intestine. The wounded coil has been found, even two or more days later, adherent or surrounded by omentum, inflamed, and full of liquid faeces which do not escape into the general cavity till the coil is disturbed at operation or autopsy.

In a case of this kind, where peritonitis is purely local, the bowel below the injury is found contracted and apparently normal; that above, in consequence of the obstruction caused by the injured coil, is distended, paralysed, and poisoned. In this it resembles the bowel above any acute obstruction of some standing, and, if it has been long in this state, it is only to be expected that, even after removal of the injured portion, it should fail to regain its functions for some considerable time.

A case of the kind already published¹ may be referred to briefly.

CASE I (O. R.).

The patient, who had been shot two and a half days previously, presented pain, rigidity, bilious vomiting. The small intestine was wounded in two places; the wounded coil was full of liquid faeces, of which none had escaped; 12 in. resected, end-to-end anastomosis made, and the bowel above emptied. Next morning the patient was better, but later bilious vomiting recurred, and he died in thirty-six hours.

Post-mortem Examination.—No other injury; no general peritonitis; no free blood. The bowel above the junction very much distended, that below it empty and contracted.

If in this case, in addition to the coil actually wounded, the intestine above it, which had borne the brunt of two and a half days' acute obstruction, had been freely removed till more healthy gut was reached, it is possible that recovery might have resulted.

The deliberate removal of distended bowel for some distance (2½ ft., 4½ ft.) above an injury was, in fact, followed by recovery in two subsequent cases¹ of this kind of eighteen and thirty-six hours' standing respectively.

But it is clear that when a patient is operated on, as is now frequently possible, within a few hours of receiving his wound, these considerations do not apply. There has not been time for the bowel above to become permanently damaged from this cause. Nevertheless, we have each of us recently met with instances of this complication arising in cases operated on within seven and eleven hours respectively.

CASE II (J. F.).

Pte. G. W. was admitted to hospital six and a half hours after injury, suffering from a bullet wound in the abdomen, which had entered below the umbilicus and passed out below the left buttock. Operation showed extensive damage to 9 inches of the lower end of the ileum; 12 inches were resected and an end-to-end anastomosis made. During the forty-eight hours subsequent to operation the patient made good progress. Sickness and abdominal distension then appeared. The obstruction became progressively worse, and the abdomen was opened a second time under spinal anaesthesia. A clot of blood was found in the mesentery in

relation to the gut above the point of obstruction. The gut for about 8 inches above the anastomosis was distended to about three times its usual size. No mechanical obstruction could be found. A lateral anastomosis was performed, short-circuiting the distended loop and the anastomosis junction. After this second operation the patient did exceedingly well; there were no further complications, and quite an uneventful recovery was made.

CASE III (O. R.).

Pte. H. F., wounded September 30th, 11.45 p.m., was operated on eleven hours later. The jejunum was found to be wounded in six places. The injured coil (about 2 ft.) was resected, and an end-to-end junction made about 1½ ft. from the duodeno-jejunal flexure. The next morning the patient was comfortable, and the pulse 76. In the evening the pulse rose to 120, and he began to vomit. This was relieved by washing out the stomach, but recurred later, and the next day (October 3rd) the abdomen was re-opened. The intestine above the union was found very much dilated, that immediately below it empty and contracted. A lateral anastomosis was made between portions of intestine three or four inches distant from the union in either direction, short-circuiting it.

After operation the vomiting recurred; great relief was given whenever the stomach was washed out, but the patient gradually lost strength, and died on October 6th.

Post-mortem Examination.—The duodenum and jejunum above the first junction were enormously dilated; the dilatation continued in a lesser degree as far as the lateral anastomosis, and there stopped abruptly; the intestine below was contracted and empty (see figure; specimen in War Office collection).

In both these cases the facts that the obstruction followed a fairly early operation, and that the distension was strictly limited to the segments of intestine above the junction, suggest that the cause lay in some interference with the nervous mechanism of the bowel.

This may have been reflex and in the nature of shock. Acute dilatation of the stomach occasionally follows operations on the viscera and in fact complicated the recovery of one case of resection.¹ Or it may be due, as has been suggested,² to an interruption of the nervous chain, so that the intestine below fails to carry on the peristaltic wave.

The theory that the condition depends on an interference with the nerve mechanism of the bowel above is favoured by Case II, for in this instance the mesentery contained a blood clot which may have very materially interfered with the nerve mechanism. A rather limited experience³ has induced us to believe that this condition is perhaps less likely to occur after lateral than after end-to-end anastomosis, and this constitutes a second argument rather in favour of the nerve mechanism being at fault, for in end-to-end anastomosis the junction is made through tissue which has been subjected to the trauma of division, while in lateral anastomosis it is made through fresh and undamaged tissue.

Probably even if the nerve mechanism is primarily at fault its action is aided by other factors; the local peri-

tonitis which is invariably present in greater or lesser degree, and the presence of free blood in the peritoneal cavity, may be considered as subsidiary causes.

CONCLUSIONS.

1. Resection of a wounded coil of small intestine is sometimes followed by obstruction, the segments of intestine above the union becoming distended, while the segment below remains contracted.

2. In cases operated on within a short time of the receipt of the injury this is probably mainly due to some interference with the nervous mechanism, caused by the injury itself and the resultant shock, and increased by other causes—for example, local peritonitis.

3. In cases operated on after a considerable interval a further cause is that continued obstruction, and consequent septic absorption, render the bowel above incapable of rapid recovery.

4. A case in which this complication has occurred may possibly be saved by a subsequent short-circuiting of the affected coil.

Note by

Colonel CUTHBERT WALLACE, A.M.S.

In the last two cases resection and circular enterorrhaphy was performed, one in the lower ileum, the other in the upper jejunum. A short-circuit operation was performed in both to relieve a distension which was limited to the segment of small gut above the line of the circular enterorrhaphy. The cause of the obstruction was a paralysis of the bowel below the operation site, which paralysis was due not to septic peritonitis but to some acquired defect.

The reason for the inert condition of the lower bowel segment is not altogether obvious. After the receipt of the injury the small bowel on both sides of the trauma becomes paralysed or inactive. This is shown by the state of the bowel as seen at

This figure represents intestine removed from Case III *post mortem*. The bowel is continuous in the form of an S, and there is no interruption at the point A. B marks the original end-to-end anastomosis, C the subsequent lateral one. The inset diagram shows the condition found at the second operation and the points at which a lateral junction was then made. (The specimen is in the War Office collection.)

operation, by the non-expulsion of its contents and by the fact that for some considerable time, at all events, the injured bowel remains in the place where it was hit. A resection is performed, and some additional trauma inflicted on the viscus. After a variable period the bowel recovers its tone, and it is permissible, I think, to believe that the parts furthest from the lesion recover first.

The lower part has no inducement to peristaltic action, but the upper segment will be stimulated by the entrance of fluids and food. The intestinal contents will be passed on until the region of the resection is reached. As far as one knows, the bowel always recovers down to the immediate neighbourhood of the lesion.

The distal segment of the bowel at a little way below the injury recovers also, as shown by the fact that a short-circuit did in one case lead to a normal function of this part.

What is, then, the cause of the functional block?

It seems due to two causes: (1) The portions of bowel immediately on either side of the lesion remain paralysed as a result of the trauma, or (2) the interruption of

Auerbach's plexus prevents the transmission of the peristaltic wave. Perhaps the first is the most probable, as in one case this portion dilated down to the anastomotic opening. If the distal portion was in good condition it should have contracted on the contents instead of becoming dilated.

In the light of the failure of the lower segment to take on its normal function, it would be advisable in these cases to make the anastomotic opening at a considerable distance from the lesion, or, perhaps better still, to short-circuit into the transverse colon, as suggested by Sampson Handley.

REFERENCES.

¹ BRITISH MEDICAL JOURNAL, August 7th, 1915. ² Ibid., April 8th, 1916. ³ *Lancet*, December 18th, 1915.

POST-OPERATIVE PARALYTIC ILEUS.

BY

H. T. HICKS, F.R.C.S.,

HONORARY GYNAECOLOGICAL SURGEON, DERBYSHIRE ROYAL INFIRMARY.

I AM very glad that Dr. Bonney and Mr. Handley have brought forward lately the subject of paralytic ileus following abdominal operations.

This serious complication has not received sufficient attention, nor has much research been made into its cause and pathology. The textbooks on surgery do not distinguish clearly this form of ileus from the more mechanical variety, which usually yields quickly to treatment.

My own experience starts from the time when I was obstetric registrar at Guy's Hospital. I saw this condition after clean hysterectomies for fibromyomata. It did not occur often, but was the subject of great anxiety and deep interest.

In my own practice, down to six years ago, I had three deaths due to this condition. The operations were: (1) Hysterectomy for a large degenerating fibroid; (2) hysterectomy for carcinoma of the uterine body; (3) hysterectomy for fibroid complicated by a very large dermoid cyst.

About five years ago I made up my mind that I would reopen the abdomen as soon as the signs and symptoms of paralytic ileus were established.

Out of 300 abdominal sections of all kinds done during this period paralytic ileus developed in five cases. All these were reopened and none died. I will give the essential points of each case.

CASE I.

Mrs. B. Operation August 1st, 1912, for a large adherent ovarian cyst. Paralytic ileus followed. Abdomen reopened on August 4th. General distension of intestine and small quantity of blood-stained fluid in the pelvis. The intestines were well stirred up and large quantities of hot saline poured in. A loop of the transverse colon was brought out and a small Paul's tube inserted into the lumen. The gut was lightly anchored to the peritoneum at the upper angle of the wound, and the pelvic cavity drained by a large Keith's tube at the lower angle. Within a few hours the vomiting ceased, and the bowels acted both through the tube and by the rectum. Subsequently the fistulous opening was closed by clamping the spur.

CASE II.

Mrs. D. Operation October 24th, 1912, for very adherent Fallopian tubes. Abdomen reopened October 28th. The same operation as above. Complete recovery. The fistulous opening was closed by resection of gut, and rejoined by lateral anastomosis.

CASE III.

Miss C. Operation December 9th, 1912, for large fibroid. Reopened on the third day. The same treatment as above, except that in this case jejunostomy was done. The fistulous opening closed spontaneously, but I had subsequently to excise about 2 ft. of small intestine and rejoin by lateral anastomosis. I heard from this patient last Easter Monday and she is quite well.

CASE IV.

Miss T. Operation June 26th, 1913, for adherent Fallopian tubes and appendix. Reopened June 28th. Peritoneal cavity washed out with hot saline and the intestines well stirred up with the hand, especially in the pelvic cavity. Vomiting ceased almost immediately and the bowels acted with the aid of a turpentine enema.

CASE V.

Mrs. X. Operation January 3rd, 1912, for a very adherent unilocular ovarian cyst. Reopened three days later. Peritoneal cavity washed out and intestines well stirred up, especially in the pelvis. A large drain was placed into the pelvis through

the lower angle of the wound. In six hours vomiting ceased, and a few hours later a turpentine enema gave a good result.

We know so little about the pathology of post-operative ileus that any opinion formed as to its cause and right treatment must be more or less speculative. Everyone is agreed that it is due to a rapidly spreading peritonitis, and that it usually begins at the site of a recent operation in the lower abdominal region, or follows on an acute septic condition, such as an acute appendix.

On one occasion only did I take a cultivation from the peritoneal cavity at the second operation. This culture showed streptococci.

Fortunately, this dreaded complication occurs very rarely. The reopening of the abdomen is a heart-breaking job for the surgeon; he naturally acts quickly, for economy in time often means life to the patient. It is difficult to notice details under these circumstances.

There are two great problems:

- (a) How to prevent the occurrence of paralytic ileus.
- (b) What to do when it occurs.

It is on the second of these that I wish to touch. Lately Mr. Handley and Dr. Bonney have written on the subject and recorded cases. I am quite certain that when the signs and symptoms of paralytic ileus are established the abdomen must be opened without delay. The question is: What is to be done when the abdomen has been reopened? The whole intestinal canal is blown up and congested; there is more or less blood-stained fluid among the lower coils, and these coils may be loosely stuck together. The hand is passed into the pelvis and the coils are stirred up. Attention is paid to the site of the primary operation, lest, perhaps, a portion of gut should have become adherent. During these manipulations large quantities of hot saline fluid are being poured into the peritoneal cavity and all parts well washed out. A large rubber tube is passed into the pelvis and brought out at the lower angle of the wound (this vent is sucked up every four hours), the wound is covered with hot fomentations, and the patient placed in Fowler's position.

Now we come to a very difficult question: Will this simple reopening of the abdomen, washing it out, and draining be sufficient to deal with the spreading peritonitis?

In two out of my five cases this was all that was done; in two I drained the large bowel simply because it was distended, and I hoped this might bring immediate relief. Beyond a local collapse near the tube insertion nothing happened until about eight hours later, and then the rectum acted, and almost at the same time the colotomy tube. This shows a general recovery of all the paralysed bowel, which a few hours before would have seemed a miracle.

Mr. Handley suggests a lateral anastomosis between jejunum and transverse colon, together with a caecal drain. He supposes that all that portion of the gut in the lower abdomen and pelvis are paralysed, while the jejunum and transverse colon are yet above the area. Thus there would be a triple block: (a) In the ileum; (b) in the caecum; (c) in the pelvic colon. Mr. Handley quotes a successful case which was already septic from a sloughing appendix. I cannot see the value of planting the jejunum into the transverse colon when there is a block at the caecum and another at the pelvic colon. A paralysed portion of gut will only drain locally, and it is extremely unlikely that the tube in the caecum would drain the whole colon.

By adopting Mr. Handley's operation, it would seem as though the contents of the upper jejunum were being emptied into an already hopelessly distended colon, let alone the dangers of a lateral anastomosis with the intestinal wall in such a condition. I note that Mr. Handley states that in his case on the day following the second operation the colotomy tube acted, and that a certain amount of material and flatus also passed by the anus. Here is the same extraordinary spontaneous recovery of all the paralytic bowel. It is almost incredible, but a fact, that this spontaneous recovery should take place so rapidly. To what is this recovery due? Is it due to the reopening, ventilating, and washing out of the peritoneal cavity? I think there is very good reason for supposing that this spontaneous recovery of many feet of intestines is due to this and not to drainage of the intestines.