

# The American Journal of Surgery

NEW SERIES, VOL. I

JULY, 1926

No. 1

## DIAGNOSTIC VALUE AND THERAPEUTIC APPLICATION OF PERUTERINE INSUFFLATION OF THE FALLOPIAN TUBES IN CASES OF STERILITY\*

I. C. RUBIN, M.D., F.A.C.S.

NEW YORK

PERUTERINE tubal insufflation was devised for the specific purpose of determining the patency of the Fallopian tubes. In order to answer this question in cases of sterility, before this method was available, one was obliged to resort to exploratory laparotomy for, in the majority of instances normal tubes are not palpable per vaginam and diseased tubes are so often implicated with diseased ovaries that they are indistinguishable by vaginal touch. In many cases where the tubal factor was not ascertained, operative procedures to relieve sterility could not but fail of their object. Thus all the otherwise technically excellent operations upon the cervix not associated with an abdominal section were futile in the presence of closed Fallopian tubes. Such an experience, to the chagrin of the surgeon and, what is more important, to the disappointment of the patient, was all too commonly encountered.

Attempts to arrive at a non-operative method to determine tubal patency were begun by me in 1914 by experiments on animals. Collargol was injected into the uterus and through it into the tubes. Roentgenograms were then made and the shadowgraphs of the uterus and tubes were studied. It was soon seen that outlines

of the tube lumen could be demonstrated. Cary appears to have been the first to try this method clinically. My own experience with peruterine injection of collargol, and of thorium, bromide and iodide solutions, was not favorable. The peritoneal reactions in the patent tube cases were disagreeable. When collargol was employed, inspissation in the tube lumen persisted for some time, an unhappy sequel in cases where the tubes were open. In instances of non-patency, however, no harm could result to the patient.

In gas, instead of the opaque solutions there was at once found the long-sought simple means to determine patency of the tubes. As it developed later, it also proved of diagnostic aid in demonstrating non-patency. The method of peruterine tubal insufflation, or tubal perflation via the uterus, was begun in November, 1919 at Mount Sinai Hospital, New York. The first clinical application was crude but effective. Oxygen was allowed to pass into the peritoneal cavity of a patient who came to the clinic for the relief of sterility. The abdomen was observed closely until it was seen to rise; the patient complained of distention and epigastric pain and, when she stood up, experienced severe pain in the shoulders and in the diaphragmatic

\* Address delivered October 1, 1925 at the Section of Obstetrics and Gynecology of the Royal Society of Medicine, London.

region. The *x*-ray plates showed very beautifully a general pneumoperitoneum. The quantity of the gas introduced into the peritoneal cavity of this first patient was estimated at about two liters.

From this first experiment were at once learned the necessity for: 1, reducing the amount of gas injected; 2, some manometric control; 3, some means of measur-

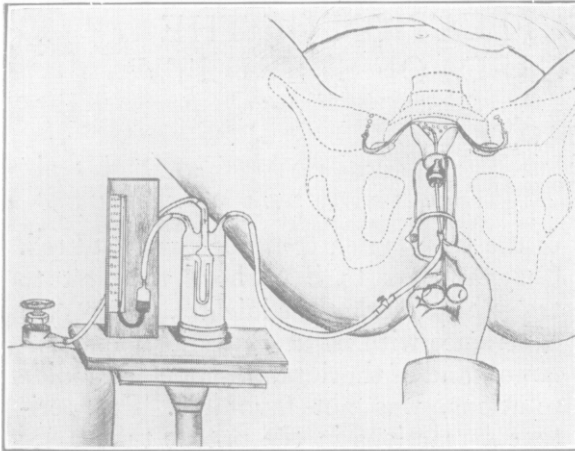


FIG. 1. Uterine cannula and bullet forceps grasping the anterior lip of the cervix, and both held with one hand firmly so that the rubber acorn fits well into the external os of the cervix to prevent leakage from the uterus. The manometer and syphon meter are shown alongside of each other and of an old style oxygen gas tank. The latter three have recently been arranged in a more convenient form, using a much smaller gas tank containing  $\text{CO}_2$ .

ing the volume of gas to be insufflated. Accordingly there were adapted the siphon volumeter and a mercury or spring-type manometer. It was soon found that a diminutive pneumoperitoneum was as easily demonstrable under the diaphragm<sup>1</sup> (subphrenic pneumoperitoneum) by fluoroscopy as the large-sized pneumoperitoneum by the *x*-ray plate. This was a definite improvement because of its clinical applicability in ambulatory cases. Another change was made by substituting  $\text{CO}_2$  for oxygen. Carbon dioxide gas is very rapidly absorbed from the peritoneal cavity. When the amount used is 150 c.c. or less, phrenic irritation and shoulder pains are but momentary. By combining these factors,

peruterine tubal insufflation became an office procedure. The test requires one or two minutes to carry out completely and within five to ten minutes the patient is ready to leave the office and able to go about her affairs.

The apparatus (Fig. 1) consists of: a tank containing 100 gallons of  $\text{CO}_2$  under one thousand pounds pressure; a reducing gauge; a siphon meter of the type employed in chlorinating water; a manometer (mercury or spring type); rubber tubing connecting the tank through volumeter and manometer to a metal cannula (Keyes-Ultzmann type), fenestrated at its tip; a rubber "acorn" (urethral tip) so fitted over the cannula as to allow the tip to enter well into the uterine cavity while the acorn itself engages the external os and thus prevents premature regurgitation of the gas along the cervical canal; a needle valve between the volumeter and the cannula. In most nullipara the acorn is not important; but in cases of relative sterility where the external os is much dilated through cervical lacerations this rubber "urethral" tip is of great importance to make possible complete air-tightness.

#### TECHNIQUE

After preparing the genital canal with tincture of iodine as for a surgical procedure, a speculum exposes the cervix. The anterior lip of the cervix is grasped with a tenaculum. Gas is released from the tank and its displacement of the water in the siphon meter is noted. This must not exceed in rate three pulsations per minute. I have found that a time ratio-flow of 15 seconds to raise the mercury column to 100 mm. is the most favorable rate of introduction of the gas into the uterus. It may be slower, that is, it may require a longer time to raise the mercury column to 100 mm., e.g. 20: 25 or 30 seconds, but it should never be less than 15 seconds.

The uniform rate flow of 15 seconds to 100 mmhg. serves as a standard of comparison when several insufflations are

necessary on the same patient. The data obtained are then more readily interpreted. We have thus learned, for example, to distinguish normally patent tubes from hopelessly closed tubes and from stenosed tubes that are amenable to treatment.

Having predetermined this uniform rate-flow of the gas the cannula is inserted into the uterine cavity to a point just below the fundus but well beyond the internal os. The pressure at the cannula tip at the time of introduction into the uterus is zero. This is accomplished by turning the needle valve well open and shutting it tight as soon as one is ready to allow the gas to pass through into the uterus. This moment is synchronous with the beginning of the pulsation in the volumeter, i.e. when the air is seen to approach the bottom of the U within the siphon. That is easily controlled by the operator and he counts the number of pulsations in order to calculate the total amount of gas he wishes to introduce.

For the average patient two pulsations suffice to establish a subphrenic pneumoperitoneum and its associated clinical manifestations. Each pulsation represents 30 to 40 c.c. of gas, as the case may be. The capacity of the gas siphon can be standardized for 30 c.c. or 40 c.c. In obese patients from three to five pulsations may be necessary. The quantity is seldom in excess of 200 c.c.

The manometer is observed in order to determine the point at which the pressure drops. This initial pressure drop indicates the point at which the gas is released through the tubes into the peritoneal cavity. In open tubes this is usually under 100 mmhg. When the tubes are closed the initial drop is not noted and the pressure rises steadily to 200. At this moment the valve at the tank should be shut and observation of the behavior of the mercury manometer should be noted for a few seconds. The cannula and tenaculum are

then withdrawn from the uterus. A scant drop or two of blood may be seen to escape from the external os but this is of no significance. The slight ooze from the anterior cervix lip caused by the tenaculum is readily controlled by a cotton tampon which is to be left in for an hour or two. Careful notice is taken of the character and location of the pains produced by



FIG. 2. Right-sided subphrenic pneumoperitoneum, 100 c.c. of CO<sub>2</sub> gas introduced through the uterus and tubes into the peritoneal cavity.

the injection of the gas through the uterus for this has definite diagnostic importance.

The patient rises from the examining table and is at once fluoroscoped. If the tubes are patent it will be possible to demonstrate with uniform regularity the presence of a single or double sided subphrenic pneumoperitoneum (Fig. 2). If this be appreciable the patient will voluntarily state that she has pains in one or both shoulders. This latter symptom depends on the one hand upon the amount of gas introduced, and on the other hand upon the sensitiveness of the patient. Hypersensitive patients will notice the shoulder pains at once; phlegmatic patients

may not notice them at all and only upon being directly questioned regarding them. Sometimes the pains are experienced after the lapse of a few minutes. In general less gas is required to evoke this symptom

are sometimes described as similar to "unwell pains." Pain on the side is seldom experienced. The fluctuations in pressure are said to be due to tubal peristalsis.

2. *Closed Tubes.* If one tube is closed

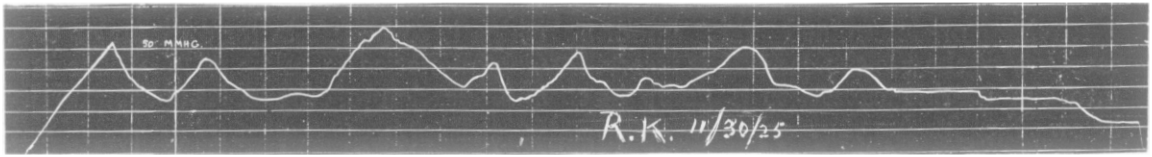


FIG. 3. Kymographic record of normal patency of the Fallopian tubes. The initial pressure rises on the manometer to 50 mm. Hg with fluctuations varying between 60 and 25 mm. Hg as the gas continues to flow through the tubes into the peritoneal cavity.

in thin than in obese individuals. When troublesome, the shoulder pains may be made to disappear instantly by the patient assuming the knee-chest posture. All patients feel well enough to dress and leave

or stenosed and the other normally open, the patient will complain of pain on the side of the tubal obstruction. If both tubes are stenosed or closed the pain is bilateral. This is due to distention of the tubes

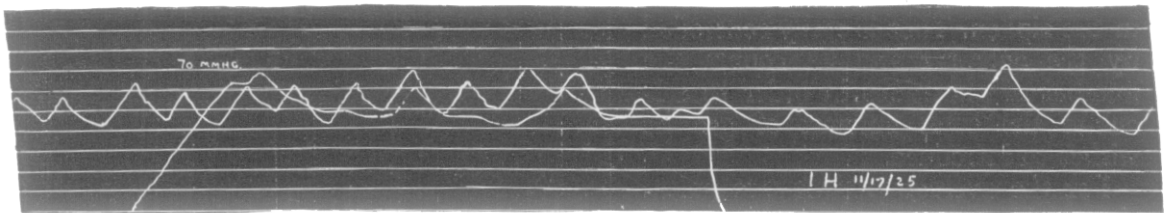


FIG. 4. Kymographic record in case of normal tubal patency showing bilateral subphrenic pneumoperitoneum. The initial pressure rises to 70 mm. Hg and typical fluctuations of the manometer are recorded.

the office within a few minutes after the test.

#### INTERPRETATION OF DATA

1. *Normal Tubes.* The mercury rises to 40, 60, 80 or even 100 mm. and drops

proximal to the point of obstruction and is present whenever the latter is situated at any point beyond the isthmus.

When the manometer rises to 200 mmhg. (Fig. 6) and uterine colic or midline pain referable to the suprasymphiseal

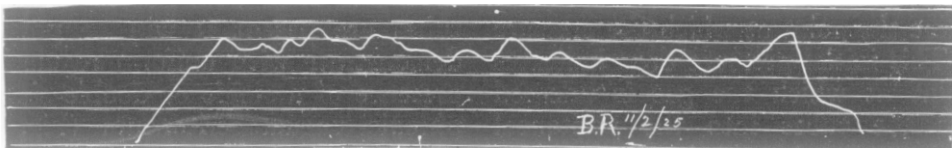


FIG. 5. Kymographic record of another case of normal tubal patency. The initial pressure rises to 60 mm. Hg with the typical fluctuations of manometric pressure indicating tubal peristalsis.

10 to 40 points (Figs. 3, 4, 5), fluctuating several times until the cannula is withdrawn. Usually the patient complains of slight pains referable to the uterus, which

area is complained of but no pain on either side, the closure is located at the intramural portion of the tubes or very near the isthmus of each side.

I have found these observations to be practically pathognomonic of the site of obstruction; and I have not had to resort to the injection of opaque solutions into the uterus for this determination. The latter has, however, definite value in cases where operative intervention is decided upon to effect an opening in the closed tubes.

*Spasm of the Tubes.* There are instances where, after a relatively high pressure is reached, a drop will be noted, indicating that a small amount of gas escapes through a minute opening. As far as my observations have gone they point to the intramural portion and the fimbriated end of the tubes as the predilection site for spasm. Studying this question with the aid of sodium bromide and sodium iodide injections into the uterus, *Kennedy*<sup>2</sup> maintains that he has been able to demonstrate isthmospasm. *Meaker*<sup>3</sup> appears to have indisputably demonstrated tubal spasm by making x-ray pictures during injection of CO<sub>2</sub> gas and after a half hour interval. During the gas injection he was able to show a distended tube, which distention was not visible a half hour later.

Recently I have attempted to study by means of the kymograph the behavior of the uterus and tubes during insufflation. The results are interesting and promise to throw light on tubal physiology in the human species. So far, they tend to corroborate the findings of Dr. Snyder and Mr. Seckinger of the Carnegie Institute in Washington, D. C. These authors studied the rhythmic contractions of the freshly removed uterus and tubes from patients at the Johns Hopkins Hospital. From the same laboratory of which George L. Streeter is the director, Ferdinand C. Lee<sup>4</sup> reports some interesting observations bearing upon this question. He injected India ink into the cornu of the uterus directed toward the Fallopian tube. The cat used in the experiment was not in the oestral period, the uterus being small and the ovaries showing no large follicles. He found "that the ink would pass into

the tubes but under great difficulty, a pressure of 280 mm. of mercury being frequently necessary in repeated experiments." "On the other hand, in the same animal, injections into the isthmus of the tube directed towards the cornu passed easily into the uterus. However, when the uterus was large and swollen and when relatively large follicles appeared in the

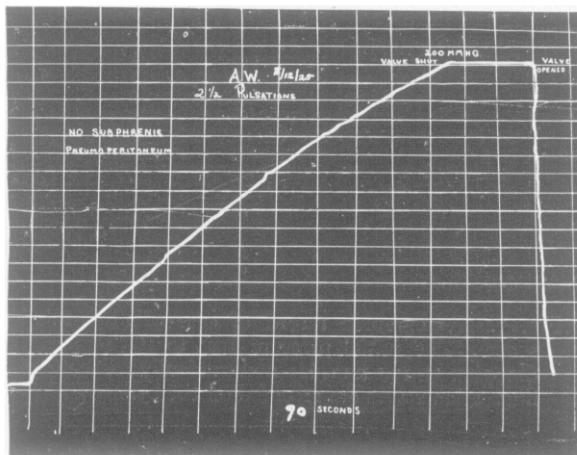


FIG. 6. Kymographic record of non-patency of the Fallopian tubes. The pressure rose to 200 mm. Hg and was maintained at the same level without describing curves on the kymograph. The drop indicates the point where the cannula is removed from the uterus.

ovary, then the passage from uterus to tube was easy. Experiments along the same lines on the dog and guinea pig have so far indicated the same general phenomenon."

"The recent report of Rubin on the various pressures necessary for transuterine insufflation of the tubes at various stages in the intermenstrual period of the same individual, is in harmony with the general principle obtained from work on the lower mammals. It is believed that the uterine end of the tube, through its varying degrees of patency, is to a great extent responsible for the differences in pressure he obtained. Furthermore, the material examined thus far indicates that the greatest patency occurs about the period of ovulation, probably a little before that time."

*Evidences of Tube Spasm.* The high pressure required to overcome an organic

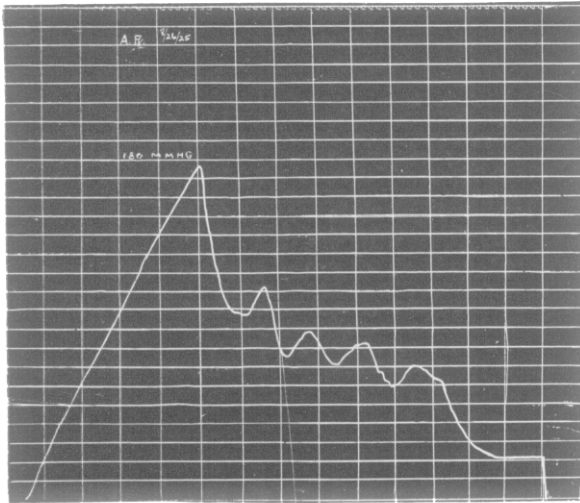


FIG. 7. Kymographic record of case of utero-tubal spasm. The initial pressure rose to 180 mm. Hg, dropping to 100 mm. Hg and gradually reducing as fluctuation waves are recorded on the kymograph.

obstruction or stenosis may be distinguished from that due to a tube spasm by the following technique. The cannula is to

tion from the cervical canal, it indicates a possible tubal spasm (Fig. 7) or the overcoming of an exceedingly narrow opening (Fig. 8) at some portion of the tube. Radiographic examination may demonstrate distention of the tube in instances where the stenosis is near the fimbria or at the ampullary portion. Vaginal palpation immediately after the insufflation may demonstrate the distended tube; a few minutes later it becomes impalpable. Auscultation over the lower lateral abdominal areas, a step in the technique as first suggested by Henderson and Amos,<sup>5a</sup> may distinguish the high pitched note of stenosis from a lower pitched note elicited on the normal side. The fluoroscopic examination or Roentgen film must show the presence of gas under the diaphragm. In favorable cases the distended tube may also be demonstrated as Meaker<sup>3</sup> has shown. Differential point: if the gas on a second examination enters the peritoneal cavity freely and at a lower pressure it may be safe to assume that the Fallopian tube in that particular case was in spasm at the first insufflation. That this must

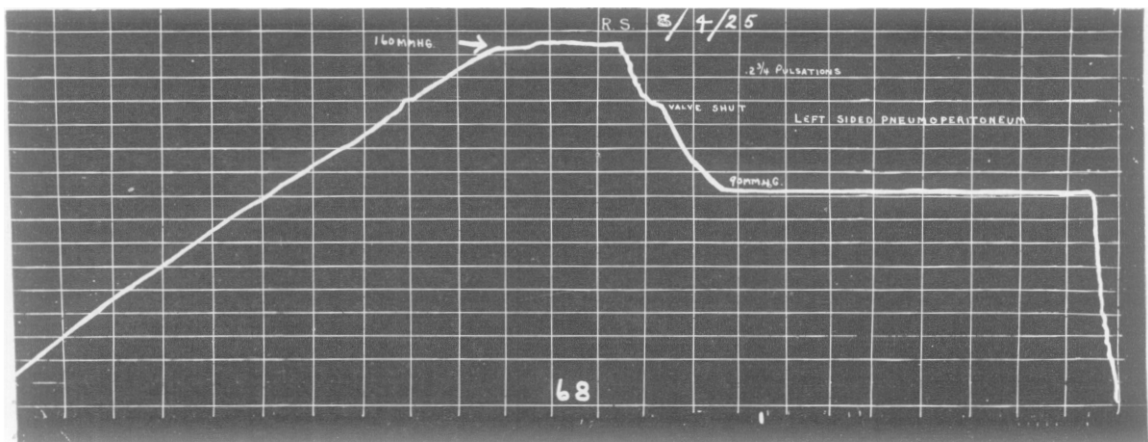


FIG. 8. Kymographic record indicating stricture or stenosis of the Fallopian tubes. The initial pressure rose to 160 and it was maintained without appreciable fluctuations for 51 seconds when a drop was noted but no attempt at describing fluctuation waves on the kymograph was noted. When the tank valve was shut there was a further drop to 90 mmhg. at which point the pressure was maintained for 40 seconds until the cannula was removed from the uterus; the pressure then promptly dropped to zero.

be held inside of the uterus after the gas has been shut off. If a drop of the mercury is noted and this is not due to regurgita-

have clinical importance especially in instances of sterility goes without saying. Further study with the kymograph may

help to establish peculiarities in genital function that have hitherto escaped attention.

#### SIMPLIFIED METHODS

It must be obvious that any method that does not offer the possibility of studying the question of tubal patency as outlined above must fail in eliciting important data. The most important factor is the uniform pressure-rate-flow and volumetric control. All methods depending upon hand pressure as when the syringe or rubber bulb is employed cannot possibly offer the even flow that can be obtained from a gas tank with an accurate release valve. There are a number of other disadvantages of simplified methods which for lack of time I shall not go into. Only one further point it may not be amiss to emphasize in this connection. Simplified methods of uterine insufflation have encouraged careless employment of the tubal patency test and may perhaps be responsible for disaster in some cases. This does not appear to have been adequately appreciated and I believe the factor of uniform pressure-rate-flow to be of prime importance for the scientific and safe application of peruterine tubal insufflation.

#### CONTRAINDICATIONS AND DANGERS

The original method of peruterine or "transuterine" tubal insufflation as it was first termed by Peterson<sup>5</sup> is apparently simple enough. It should be carried out in accordance with the rules that careful experiment and established experience have indicated. The patient must present none of the cardinal contraindications. There must be no evidence of pelvic or genital suppuration, no pelvic tenderness, no inflammatory masses, no fever; nor must she be menstruating or bleeding from other causes at the time of insufflation. She must not be a patient who is suffering from serious cardiac, renal, pulmonary or great general metabolic disturbances. These latter conditions clearly forbid any but imperative diagnostic manipulations. As they arise in individuals who, in general,

form poor subjects for pregnancy and labor there would seem to be no need or value in subjecting them to the test of tubal patency for diagnosis and therapy.

The dangers incidental to the method may be briefly summarized as due to: 1. Misemployment of the procedure without due regard for the rigid rules of the technique. 2. An unfavorable time with regard to the menstrual cycle. 3. Ill-chosen cases.

It may be said that where the test has been used most extensively and adequately the cases aggregating thousands, no untoward results have been noted. Peterson and Cron, Ward, Aldridge, Meaker, Rongy, Hirst, Hunner, Bonney and many others besides myself have seen no bad effects. However, two fatalities have been reported to me as occurring in New York City, both of them inexcusable. A very careful inquiry into the circumstances of these deaths showed that the operator in each case violated the rules of technique besides improperly selecting the case. In one case death was due to shock induced by a terrific injection of the gas in a woman of forty-two, a para-iv suffering from cardio-renal disease. In the other case death was due to embolism, an excessive amount of gas under great pressure being introduced into the genitals of a patient suffering from multiple fibroids and bilateral pyosalpinx; forcible dilatation of an amputated cervix preceded and curettage followed the insufflation.

The danger from embolism in properly selected cases can be dismissed from consideration if the test is done correctly.

The only possible untoward effects may arise in those infrequent instances of chronic tubal suppuration where the fimbriated end is still patent. As the pus, even in these cases is usually innocuous, the danger from spilling into the peritoneal cavity will not be appreciable. This, of course, presupposes that the test is carried out properly. Absence of tenderness on bimanual examination and absence

of reaction, may be taken as an assurance that the insufflation will not be followed by serious sequelae. In doubtful cases the sedimentation test and observations on the behavior of the temperature for twenty-four hours following the vaginal examination help to diagnose the presence of latent or subacute pelvic inflammation. A routine urethral and cervix smear of each patient treated for sterility adds to the safety and as this is carried out in each case it will help to weed out the infected cases. The iodine disinfections of the cervical canal also aids in reducing sepsis to a negligible minimum.

#### CHOICE OF TIME

The most favorable time to carry out peruterine tubal insufflation is from four to seven days after the cessation of a menstrual flow. During this time the endometrium is flat, the uterine ostia of the tubes are not obstructed by the swollen endometrium obtaining in the premenstrual phase and there is less apt to be bleeding. Moreover it is the safest time in that it will not interfere with a possibly impregnated ovum. Insemination soon after a post-menstrual insufflation will give the best chance for the spermatozoa to reach the tubes where they may await and impregnate the ovum. Since adopting this rule I have noted a greater incidence of pregnancy.

#### REPETITION OF THE TEST

Cases in which the tubes are demonstrated to be normally patent do not require a repetition of the test. If a subphrenic pneumoperitoneum is not produced the first time, however, it is well to repeat the insufflation at an interval of a month. Several trials may be made during the one examination but it is preferable to defer the second trial. Three or four tests at the same relative date from successive regular menstrual periods have been carried out. A fifth or sixth trial can do no harm where the patient

is anxious for a therapeutic result. Several of my patients proved to have tubal patency on a fourth test and subsequently gave birth to normal children. The second and third tests were done for corroboration of the original findings and for the purpose of formulating a more reliable prognosis. The indication for a plastic operation upon the tubes may at the same time be clearly established.

#### EFFECT ON THE NEXT MENSTRUAL PERIOD

The next menstrual period is sometimes ushered in two or three days early. Peterson and Cron<sup>6</sup> have called attention to the relief of dysmenorrhea in some cases and I have noted this in quite a number. Slight staining follows the insufflation for a day or two in a fair proportion of the cases but it needs no special attention.

#### THERAPEUTIC APPLICATION OF PERUTERINE TUBAL INSUFFLATION

From the very outset the method was obviously one that might have therapeutic as well as diagnostic value. Some authors appreciated this possibility and called attention to it. Peterson and Cron were the first to publish a paper on the therapeutic value of transuterine gas inflation.<sup>6</sup> I must say that although in this respect personal observations were accumulating it was not until May 1925 that I was able to report at the meeting of the New York State Medical Association upon 95 cases of pregnancies out of a series of 1000 consecutive insufflations. My chief interest until then was focused upon developing peruterine tubal insufflation as a diagnostic procedure.

Peterson and Cron state that "a number of patients examined for sterility by the Rubin test where the gas had been forced through the tubes, reported that pregnancy had followed without change of other conditions present during the time they have been desirous of children. This led us to send follow-up letters to all women in whom gas had been successfully



forced through the tubes, omitting, naturally, those cases where our investigations had shown that the husbands were the cause of sterility" . . . "at varying periods following the Rubin test 13, or slightly more than one third of those women, became pregnant." Thirty-six out of forty-seven women written to replied to their questionnaire. "Thirty women had never been pregnant. Six women had conceived earlier in their married lives. Since four of the six women who were relatively sterile became pregnant after the passage of gas through the tubes while nine of the thirty who were absolutely sterile conceived after gas inflation it follows that something more than the mere passage of the gas and mechanical opening of the tubes must be considered in trying to explain the reason for the higher per cent of pregnancies in those women who had previously conceived."

"Pregnancies in ten went to full term. Three resulted in spontaneous abortion at the third month. The younger the woman the greater will be her chance of conceiving. All but three became pregnant within six months after inflation (10 cases). Five had only one normal period. The shorter the period of sterility the more quickly pregnancy supervened. None of the cases who conceived were operated on after the inflation and no treatment was instituted."

The analysis of the cases of pregnancy following peruterine tubal insufflation made by these pioneers with this method has formed a basis for comparison with my own experience. In my series of a thousand consecutive private patients seeking relief from sterility, ninety-five became pregnant following tubal perflation, thus demonstrating that this diagnostic test had a therapeutic effect. These patients reported this fact voluntarily, no systematic questionnaire having been sent out. As no complete survey of this series has been made, the future may show the proportion of successful cases to be greater than 9.5%.

There can be no doubt that introducing gas through the uterus and tubes into the peritoneal cavity does help certain women to conceive. The literature contains definite statements in this respect. Rongy was among the first to make special mention of pregnancy following the use of uterine insufflation and reported four pregnancies out of one hundred and fifty-two cases examined by that method.<sup>7</sup> Besides Peterson and Cron's cases S. R. Meaker<sup>8</sup> reports three cases of women married and sterile for two, four and ten years, respectively, in whom pregnancy followed promptly upon the transuterine insufflation of gas. Two became pregnant immediately and the third became pregnant two months after the test. In each case considerable difficulty was encountered in forcing gas through the tubes. This was accomplished in the first attempt in two cases and at the fourth attempt in the third case. Meaker urges, that insufflation should be tried as a routine therapeutic measure in all cases where every factor aside from the tubes has been excluded. In another publication Meaker has collected forty cases, including his own three, of pregnancy following transuterine insufflation.

Discussing Henderson and Amos' article, Cron<sup>9</sup> states that of 58 patients to whom he had sent questionnaires 14 reported pregnancy. The majority became pregnant after one or two months, some after a second inflation. Incidentally, dysmenorrhea was relieved in some cases also.

Heinrich Guthmann<sup>10</sup> reports that of 15 patients on whom peruterine insufflation was done three became pregnant soon after the test. He draws no conclusions.

P. H. Charbonnet<sup>11</sup> reports the case of a woman with a normal menstrual history, married six years without becoming pregnant. Pelvic examination was negative. The gas pressure rose to 200 mm. Hg.; a second attempt resulted in the gas pressure rising to 180 mm. Hg. and suddenly dropping to 130 and 100 mm. Hg. One hundred and twenty c.c. of gas were

used. She missed the following period and was four months pregnant at the time of his report.

Aldridge<sup>12</sup> reports 600 cases examined by the peruterine insufflation. Nine patients who were insufflated became pregnant. Other cases may have occurred but no systematic inquiry had been made. One woman who had been married four years without conceiving required a maximum pressure of 250 mm. Hg. at two trials. She became pregnant soon after the third test which required 180 mm. Hg. Another woman of 32, married eight years, had undergone a resection of the right tube and removal of a right parovarian cyst. On September 21, 1921 she was insufflated, the maximum pressure reaching 120 mm. Hg. On January 10, 1923 she was found to be pregnant four months.

A third case was that of a woman of 30 married eight years with one child seven years old, became pregnant after the period following insufflation, the maximum pressure being 170 mm. Hg. Another woman of 26, married eight years, with one full-term seven year old child underwent a plastic operation upon her cervix-uteri, resection of the left tube and ventro-suspension, June 26, 1920. Uterine insufflation with maximum pressure of 190 mm. Hg. was performed. (Date not given.) On September 20, 1922 she was five and one-half months pregnant.

A patient of 22, married six years with one full-term five year old child underwent uterine insufflation December 7, 1922, the maximum pressure being 160 mm. Hg. On January 26, 1923 she was dilated and curetted. At her last examination in the follow-up (no date given), she was eight months pregnant.

Hirst and Mayer<sup>13</sup> report three cases in women "who became pregnant so soon after the Rubin test that we are disinclined to view this phenomenon as incidental."

In their first case, a woman of 30 married eight years, who had had a dilatation and curettage for the relief of sterility four

years before, on December 12, 1921 underwent a peruterine insufflation and the pressure rose to 150 mm. Hg. Patency of the tubes was proven by the fluoroscope. On February 3, 1922 she was found pregnant.

A second case was that of a woman of 26, married seven years and never pregnant. Dilatation and curettage one year after marriage. The pelvic examination was negative. By insufflation test October 4, 1921 the Fallopian tubes were found patent. In January 1922 she missed her menstrual period and proved to be pregnant.

The third case was a woman of 27 married three years. Dilatation and curettage eighteen months after marriage the uterus being then retroverted. Peruterine insufflation December 27, 1921 indicated non-patency. Before the test was to have been repeated she had missed her period and examination later revealed an undoubted pregnancy. I have had several cases similar to this last-mentioned one of Hirst and Mayer and feel that in these particular instances uterine insufflation exerts a therapeutic influence.

Ottow<sup>14</sup> of Dorpat believes that as a therapeutic measure the procedure is dangerous in the hands of the general practitioner because of the possibility of its lighting up a gonorrhoeal infection. With this view there can be little disagreement except that the careful general practitioner who had acquired the technique of uterine insufflation may safely add this to his general diagnostic armamentarium.

The incidence of pregnancies following the use of peruterine tubal insufflation is greater than the published reports would tend to show.

In November, 1923, I sent out questionnaires to individual operators and clinics using the "transuterine" insufflation apparatus which was made according to my design. Fifty-eight replies were received, thirty-five of which contained more or less complete data and twenty-three gave

scanty data because the method had been but too recently used by the respondents. Of the thirty-five returned questionnaires containing data, twenty-four gave figures with respect to pregnancy following transuterine tubal insufflation. There were fifty-two pregnancies out of a total of 763 patients treated for sterility by the method of uterine insufflation.

These reports are but a few from the published and unpublished records which by now must have reached a substantial number. From them alone several conclusions may be drawn as to the therapeutic value of peruterine tubal insufflation. The cases are properly chosen and serve to illustrate the type that may be benefited by the insufflation. The greater number of the women were married four or more years and the sterility must in all probability have been due to some obstruction in the tubes because of the initial high pressure. (Cases reported by Hirst, Mayer, Aldridge, Charbonnet, Meaker and Mandelstamm.)

Particularly may the test be said to be of therapeutic value when a woman sterile for a period of five years or more becomes pregnant the month following a peruterine insufflation. This therapeutic result may also be ascribed to the test even though two months elapse before pregnancy ensues. If other measures had been tried without avail the insufflation procedure may be presumed to have exercised a therapeutic effect. When the maximum pressure is not in excess of 100 mm. Hg. and pregnancy soon follows it may be a mere coincidence. However, as will be discussed later, the procedure may alter uterine conditions in such manner as to account for the relief of the sterility.

In younger women and those who are married a short time the therapeutic value of the test is problematic. I have a strong reluctance in employing the test on women married less than one year. Yet there are women who for one reason or another urgently appeal for relief from an infertile mating of six months or more.

These women, young or old, are not content to wait the traditional period of three or five years before considering themselves sterile. Modern society has so accustomed us to the delayed birth of the first child that we have almost come to accept it as the normal. Yet Matthews Duncan<sup>15</sup> has shown that on the average the first child is born about sixteen months after marriage. Giles,<sup>16</sup> quoting Duncan, is led to the conclusion that when the first year has passed without any sign of pregnancy, an examination should be made to ascertain whether there is any cause. This question as to the time limit that should be set as marking a sterile marriage has engaged the attention of the profession and the laity for a long time.

A couple who have lived according to the normal marital habit, the wife a virgin at the time of marriage and the husband potent and free from venereal infection, may be justified in seeking an explanation for the failure of conception after six months. I shall not go into the conditions that render a woman absolutely sterile; such cases are rare indeed. Generally speaking, there are contributing factors congenital or acquired, which most often are remediable. The examination may reveal no gross or apparent reason for the childlessness though the couple be married six months or sixteen years. In either case they are potentially fertile. Instances of the first child being born from ten to twenty years after marriage are not infrequent and the incidence of first childbirths in the premenopause are also not unknown. These are encountered in women who have long ceased to undergo any treatment for their sterility; some may never have applied for medical relief. Therefore coincidence cannot always be dismissed. If peruterine insufflation in otherwise unsuccessful and apparently hopeless cases facilitates fertility in an increasing number of women it is fair to ascribe to it a therapeutic value equal to other well-established and well-recognized

therapeutic agencies. Especially is this true where a mechanical hindrance has been overcome by the insufflation.

SUMMARY OF PREGNANT CASES FOLLOWING PERUTERINE INSUFFLATION

In the 102 pregnancies occurring in my later series, 21 had been married between five and fifteen years. In 18 cases the marriage was of between three and five years duration and 61 had been married between one and three years. Two were married less than one year. One was a nulliparous woman 40 years old, married three months; and the other a woman of 19 married six months. In each case there was a sufficiently important reason to make them seek advice concerning their infertility. If one applied rigid critique in the analysis of these cases it would have to be admitted that the 18 women who became pregnant after a period of nulliparity of five years or more were aided by peruterine insufflation. Until more data accumulate the five year limit of nulliparity may serve as a criterion.

One hundred and one women became pregnant after peruterine tubal insufflation.

Primary sterility.....	63 cases
Relative sterility.....	39 cases
	102 cases

Of the cases of relative sterility there were:

One child sterility.....	11
One child and one miscarriage.....	4
One child and two other spontaneous miscarriages.....	2
One stillbirth.....	2
Two children by a first marriage.....	1
One or more spontaneous miscarriages.....	12
One or more induced abortions.....	5
Ectopic gestation.....	2
Total.....	39

Married one year and under (2 cases)	15
Married between one and two years..	32
Married between two and three years	15
Married between three and four years	17
Married between four and five years	11
Married between five and six years	5
Married between six and seven years	4
Married between seven and eight years	5
Married between eight and nine years	3
Married eleven years.....	2
Married fifteen years.....	2
Married but number of years unknown	1
Total.....	102

HOW DOES PERUTERINE INSUFFLATION AID THE STERILE WOMAN?

1. By establishing patency of the genital tract from the external os to the abdominal opening of the Fallopian tubes. Any cervical canal that is patulous to the uterine cannula used in the uterine insufflation is ample for the entrance of spermatozoa. If the external os appears punctate or pinpoint but admits the cannula, this is proof that it is wide enough to allow semen to enter the cervical canal. The cannula at the same time stretches it somewhat, rendering it more patent for a varying period of time. Should coitus take place shortly after this procedure the spermatozoa must have a better opportunity than otherwise of effecting an ascent into the uterine cavity.

2. In some cases a mucous plug not visible at the external os but occupying the deeper portion of the cervical canal is seen to be expelled after the insufflation and on withdrawal of the uterine cannula. I have the impression that the removal of this mucous plug in this manner may be the important factor in some of the successful cases.

3. By separating mild agglutinations of the folds of the tubal mucosa, by straightening out tortuous tubes, especially of the infantile type, by dislodging a mucous inspissation from a narrow to a wider portion of the tube, by actually separating adhesions at the fimbriated end in cases

requiring 150 to 200 mm. Hg. or more, a way is opened for the descending ovum to meet the ascending spermatozoa.

4. Still another factor not to be lost sight of is the psychic impression which peruterine insufflation makes on the patient. Although the exact nervous mechanism is not at present clear there are women who respond to the physical stimulation of peruterine insufflation through the psyche acting upon the autonomic genital apparatus. Whether it induces a certain amount of relaxation in otherwise spastic tubes, the uterine openings of which are practically closed, must await further inquiry. That there actually exists in certain tubes spasm sufficient to close the uterine ostium in a manner similar to the closure of the internal os of the uterus has been recently demonstrated. I have been able to convince myself of the presence of spasm in a fair number of cases and believe that it is very common in the premenstrual or pregravid state and less common in the postmenstrual interval. Overcoming such spasm may be supposed to exert a therapeutic influence at least in some cases.

#### INDICATIONS FOR PERUTERINE INSUFFLATION

1. Primary sterility, where contributing causes, including those for which the husband might be responsible, have been eliminated and some operative procedure is contemplated. Here it has a definite prognostic as well as diagnostic value.

2. Primary sterility in which the patient is known to have passed through a gonorrhoeal pelvic infection soon after marriage and is at the time of the inquiry free of pelvic symptoms.

3. Sterility following a pelvic exudate or abscess complicating a puerperium or abortion, with or without the history of an operation and where resolution has apparently taken place.

4. Primary sterility in which the patient had peritonitis of appendicular origin in the premarital or postmarital state, to exclude tubal occlusion by peritoneal adhesions.

5. One-child sterility without the definite history of pelvic infection.

6. After one whole tube and part of another have been removed for hydrosalpinx or pyosalpinx (conservative surgery).

7. After unilateral ectopic pregnancy to determine the patency of the residual tube.

8. After salpingostomy to determine the success of the operation which was calculated to effect an opening of occluded tubes.

9. After sterilization by tube ligation, to test the patency of the tied or severed tubes.

10. After multiple myomectomy in nullipara to make certain that at least the uterine ostium of the tube has been left intact.

11. Sterility of long standing where pelvic masses are palpable and clinically diagnosed as fibroids or "chronic disease of the adnexa." The test shows whether or not the tubes are open.

12. As a therapeutic measure to eliminate the tubal factor in sterility.

The causes of sterility are too often obscure. It appears that at least the mechanical factor of patency should be possible of determination in most cases. The method of inflating the uterus with carbon dioxide gas with the production of an artificial pneumoperitoneum obviates the necessity of surgical exploration and is especially serviceable in the obscure cases.

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