otherwise everything normal. Physiologic senile changes were apparent. As a last resort pelvic massage was advised and at this date she has only had six treatments. The tenderness and soreness is slowly but surely disappearing.

The other three patients, like so many dispensary cases, drop out if they feel a little better. Neither of these had over three or four treatments and we know little as to the result so far as they are concerned; one of them reported and said she was well.

Another interesting case in this group was Mrs. R., aged 27 years, married three years, sterile, complaining of severe pain on sexual connection, so much so that she has become melancholy and unhappy because of her inability to discharge the marital relations satisfactorily to herself or husband. The uterus was found sharply anteverted, with great tenderness over the uterosacral ligaments; otherwise negative. This patient gave a history of having had a dilatation of the cervix, pessaries and all sorts of treatment. Pelvic massage was advised as a last resort and as an experiment. After a dozen treatments of twenty minutes duration every third day this patient reported for examination, when all tenderness had disappeared and the marital relations were most satisfactory.

In a summary of the results obtained thus far from pelvic massage at the Gynecean Hospital, there can be no hesitancy in stating that in selected cases of undeveloped infantile conditions of the pelvic organs it deserves first consideration. There may be cases of this class in which, from a moral standpoint, it would be better not to advise it; but to condemn a treatment which offers prospective good simply because there is an occasional one whose perversity or frowardness would be against its use is, to say the least, contrary to that liberality of medical men who have always accepted those truths which are founded on practical results.

In tender stumps, after removal of the appendages, and indeed after all surgical measures for inflammatory or chronic pelvic disease, where there remains a certain tenderness with or without adhesions, provided sufficient time has elapsed to overcome these conditions, which would contraindicate massage anywhere, it offers a promising field.

In old exudates, the result of pelvic cellulitis, etc., it is worth a trial. In one instance, good results were obtained where all other measures failed. In anteversion with tender uterosacral ligaments, or in any general pelvic tenderness without inflammatory pathologic conditions and associated, as many of these cases are, with painful coitus, pelvic massage offers the most promising results, as three of these cases have verified.

In the cicatricial tenderness which sometimes follows plastic operations, it acted very satisfactorily in one case.

In simple uncomplicated endometritis it only increased the leucorrhea and appeared to do more harm than good.

In subinvolution complicated, as these cases mostly are, by endometritis, it increased the discharge, aggravating the endometrial condition, which continued the subinvolution.

In retroversion, with or without adhesions, it gave negative results; and in one instance where there were firm adhesions, uterus fixed, it greatly increased the lumbosacral pains as well as other reflex symptoms.

In fibroid conditions it stimulated them to more rapid growth, and increased the menstrual and intra-menstrual discharge.

In tubo-ovarian disease, chronic or inflammatory, or any inflammation about the appendages, it is capable of doing much harm.

One important point noticed in most of these cases

was that the massage increased intestinal peristalsis, and produced a regularity of the bowels which was unknown to most of these patients without large doses of cathartic medicines.

It is to be regretted that sufficient time has not elapsed to speak advisedly as to the reliability of this treatment in sterility. But it is not too much to say that the satisfactory increase in the condition of the organs dependent upon pregnancy has been such as to give us encouragement in this unfortunate condition. One of these cases, in which sterility has existed and in whom there is marked improvement in the development of the uterus and regularity of the menses, has missed one menstrual period, associated with other signs of early pregnancy.

It has been noticed that, in a number of these cases, there was a concomitant condition of hemorrhoids, which were relieved in every instance. Whether this was due to the increased intestinal peristalsis producing a normal action of the bowels, or by stimulating these veins to greater activity, as well as the increased cellular changes taking place in the infiltrated connective tissue surrounding the rectal veins incident to the massage, is a question to be answered only in a further study of its value in this condition.

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FORMALDEHYDE AS A PRACTICAL DISINFECTANT.

Read before the Johnson County Medical Society, Sept. 8, 1897.

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The study of disinfectants and disinfection is of interest to all who are concerned in the preservation of public health. Recent years have afforded the means of placing this study upon more of a reliable and scientific basis. Frequent observation has noted the fact that although a certain disinfectant may be possessed of active germicidal properties in the laboratory, where it can generally be brought in direct contact with the microbe, it often fails signally when applied on a larger scale or for practical purposes.

Recently formaldehyde has been brought forward with considerable enthusiasm as a disinfecting agent, and the series of experiments embodied in this paper were directed toward determining to a certain extent its utility in this respect. In connection with a cursory review of the existing literature on the subject, an effort has been made to draw into comparison the several agents and substances heretofore used more prominently. Formaldehyde (formal, formalin) is the aldehyde of methylic or wood alcohol and appears on the market as an aqueous solution representing 40 per cent. of the gas. For some time it has been known to the biologist and the pathologist as a fixing, hardening and preservative agent of superior value. Since 1888 its germicidal properties have been recognized and of late have had extensive practical application. As a disinfectant it is used in three forms; aqueous solution, moist vapor and pure gaseous state. In the liquid form the standard 40 per cent. solution can be diluted to varying strengths and the dilutions as generally expressed refer to the commercial formaldehyde rather than to the pure gas itself.

To determine its germicidal properties a number of tests were made with the organisms bacillus anthracis (sporing) and staphylococcus pyogenes aureus. Addition of formaldehyde was made to bouillon tubes

in strengths of 1 to 3000, 1 to 2000, 1 to 800, 1 to 500, 1 to 200 and 1 to 100, inoculated from virulent cultures of above-named organisms showed no growth in any case, control cultures being made in every instance. Addition of formaldehyde to virulent bouillon cultures produced death of the organisms in ten and fifteen minutes, and subsequent sub-cultures showed no growth. It would seem from this that solutions of 1 to 200, 1 to 500 and 1 to 1000 would be appropriate for disinfecting surgical instruments. Scalpels left in these solutions as long as twenty-four hours showed no tarnish or apparent change in the cutting edge.

As a deodorant I have found solutions of 1 per cent. effective in removing all vestige of odors from putrefying meat. Dr. K. Walker¹ has sterilized and removed all odor from feces by a 10 per cent. solution in ten minutes. Disinfection by means of moist vapor, while highly effective in a small amount of space, has not been proportionately successful when applied to a larger area.

The vapor of formaldehyde is produced by saturating cotton or cloth with a 40 per cent. solution, placing it in a shallow dish and covering all with a bell jar; infected substances exposed to this vapor are sterilized in short time. The experiments of J. J. Kinyoun² show that cover slips spread with staphylococcus pyogenes aureus, bacillus diphtheriae, bacillus typhosus and sporing bacillus anthracis were destroyed in ten minutes. In applying this method to large areas the difficulty of so arranging the evaporation as to reach all parts of the room and the rather slow diffusion of the moist vapor has retarded the adoption of this method on a more extensive scale.

Formaldehyde in the pure gaseous state has shown itself to be by far the more satisfactory agent for the disinfection of rooms and wards. The gas is produced in two ways: 1, by generation from wood alcohol; 2, by the heating of commercial formaldehyde in an autoclave or special boiler to three or four atmospheres pressure and then allowing the gas to escape. The first procedure being carried on by means of lamps or generators, of which there are a number of different kinds in use; the Tollens, Gambier and Krell type prevailing in Europe, while the Hollister and Moffatt generators are being extensively introduced by their respective makers in this country. Two sizes of the Hollister lamp are manufactured, being designated respectively as No. 1 and No. 2, the first having a capacity of one quart of wood alcohol, converting the same into formaldehyde gas in twenty-four hours, while the No. 2 generator holds four quarts and uses up the contents in twenty hours. To operate, the platinum decomposing gauze is heated to redness, after which it is placed in the dome opening where sufficient heat is generated by the decomposition of the mixture of methylic vapor and air as it comes in contact with the gauze, to maintain the incandescence, which is kept up until all the alcohol has been converted.

The first tests were made with the No. 1 generator in a room 12 by 13 by 14 feet, capacity 2184 cubic feet, in which were two windows and one door, with very little leakage.

Test objects.	Exposure, 16 hours.	Exposure, 24 hours.
Cover slips spread with B. anthracis	Growth in bouillon after 24 hours' incubation.	Growth after 48 hours' incubation.
Staphylococcus pyogenes aureus...		
B. diphtheriae		
B. of typhoid...		

Control cultures were made in each case to test the vitality of the organisms.

Test objects.	Exposure, 16 hours.	Exposure, 24 hours.
Gauze and cotton infected with pus from surgical kidney.	Growth after 24 hours' incubation.	Growth upon agar plates after 48 hrs. permitted separation of staphylococcus pyog. aureus and bacillus coli communis.

The last-named infected objects were placed in different parts of the room, one piece being suspended three feet above the lamps.

Disinfection was negative and the conclusion drawn that the space was too large for the size of the generator, so the next tests were made in a smaller room, having the dimensions of 7 by 8 by 10½ feet, or 588 cubic feet.

Test objects.	Exposure, 17 hours.	
	After 24 hours' incubation.	After 72 hours' incubation.
Cotton infected with Staphylococcus pyogenes aureus.	No growth.	No growth.
Cover slips spread with Staphylococcus pyogenes aureus .	No growth.	No growth.
Bacillus anthracis (sporing) . . .	No growth.	Growth.
Bacillus of typhoid	No growth.	No growth.
Bacillus diphtheriæ	No growth.	No growth.
Bacillus mallei	No growth.	No growth.
Cover slips spread with Staphylococcus pyo- genes aureus Bacillus of typhoid Bacillus diphtheriæ	wrapped in four layers of towel.	Growth. Growth.

Agar plates inoculated with the following.	After exposure agar tubes were inoculated from the plates and with them placed in the incubator.	
	Exposure, 14 hours.	Exposure, 21 hours.
	72 hours' incubation.	72 hours' incubation.
Bac. anthracis.	No growth on plates. Growth on agar sub-culture tubes.	No growth on plates. Growth on agar sub-culture tubes.
Bac. diphtheriae.	No growth on plates. No growth on agar sub-culture.	No growth on plates. No growth on agar sub-culture.
Staphylococcus pyogenes aureus	No growth on plates. No growth on agar sub-culture.	No growth. No growth.

A second lamp, No. 1, was placed in the room and one test made while using two lamps, as follows:

Test objects.	Exposure, 15 hours.	Exposure, 21 hours.
	72 hours incubation.	72 hours' incubation.
Cover slips spread with B. anthracis.	Growth.	Growth.
B. diphtheriae.	No growth.	No growth.

Disinfection was accomplished in all instances with the exception of the active sporing organism of anthrax and wherever any slight concealment of the test objects was made. The last series of tests with the No. 1 generator were made in a very small space in order to determine its utility for surgical sterilizing purposes. The sterilizing chamber used for the purpose was made from an old metal hot air sterilizer, the lamp being placed under it and the chimney passing through an opening cut out to fit the same. Dimensions of the sterilizer, 13 by 17 by 12 inches.

Test objects.	Exposure 10 min.	Exposure 15 min.	Exposure 20 min.	Exposure 30 min.
Gauze soaked in bouillon culture of				
Staphylococcus pyog. aur.	Growth.	No growth.	No growth.	No growth.
Bacillus of typhoid.	Growth.	No growth.	No growth.	No growth.
Bacillus diphtheriae.	Growth.	No growth.	No growth.	No growth.
Bacillus anthracis.	Growth.	No growth.	No growth.	No growth.
Staphylococcus pyog. aureus	Growth.	No growth.	No growth.	No growth.
in four				Growth.
B. of typhoid				Growth.
B. diphtheriae				No growth.
apron.				
Ligatures soaked in bouillon culture of				
Staphylococcus pyog. aur.		Growth.	No growth.	No growth.
Bacillus diphtheriae.		Growth.	No growth.	No growth.
Covers spread with				
Staphylococcus pyog. aur.	Growth.	Growth.	No growth.	No growth.
Bacillus diphtheriae.	Growth.	No growth.	No growth.	No growth.
Bacillus mallei.	Growth.	Growth.	No growth.	No growth.
Bacillus anthracis.	Growth.	Growth.	Growth.	Growth.

In the last-named tests the same difficulty seems to present itself of the lack of penetration of the gas, which is such an important requisite in surgical sterilization.

For further experiments in room disinfection the No. 2 generator was applied. Room 12 by 13½ by 14 feet; 2184 cubic feet.

Test objects.	Exposure, 20 hours.
Covers spread with	
Bacillus of typhoid.	No growth.
Bacillus diphtheriae.	No growth.
Staphylococcus pyog. aur.	concealed Growth.
Bacillus of typhoid	by five Growth.
Bacillus diphtheriae	layers of Growth.
Bacillus pyocyaneus	apron. Growth.
Gauze soaked in bouillon culture of	
Bacillus anthracis.	No growth.
Staphylococcus pyogenes aureus.	No growth.
Bacillus anthracis concealed by two	
layers of towel	Growth.

Room 12 by 11 by 26 feet; 3498 cubic feet.

Test objects.	Exposure, 20 hours.
Covers spread with	
Bacillus anthracis.	Growth.
Bacillus diphtheriae.	No growth.
Bacillus pyocyaneus.	No growth.
Gauze soaked in bouillon culture of	
Bacillus diphtheriae.	No growth.
Staphylococcus pyogenes aureus.	No growth.
Covers spread with	
Bacillus of typhoid.	Growth.
Staphylococcus pyogenes aureus, con-	
cealed in the inside of a coat.	Growth.

The second method of generating the aldehyde gas, introduced by Trillat, consists in the use of an autoclave or special boiler. The form of autoclave devised by Trillat³ is slightly different from the one ordinarily used for sterilizing purposes, with superheated steam. The autoclave used in connection with the following experiments is of the Rohrbeck (Berlin) type and was formerly used in the laboratory for sterilizing work. The formaldehyde, 40 per cent. solution, is placed in the copper container, with the addition of a neutral salt, such as chlorid of calcium in the proportion of 4 to 5 per cent., the heat is applied from below, the cover being fastened down firmly; when the manometer indicates a pressure of three and one-half to four atmospheres the escape tube is opened and the gas issues forth, as a dry vapor, with remarkable force and diffuses very rapidly throughout the room. The autoclave may be operated in the room that is to be disinfected, or it can be placed on the outside and the gas conducted by means of a connecting metal or rubber tube through

the keyhole or opening made in the door for the purpose. The last-named way is decidedly preferable for the operator, as the irritating inhalation of the gas is avoided. Test No. 1. Room 588 cubic feet, autoclave in the room, 300 c.c. of formaldehyde used.

Test objects.	Exposure, 12 hours.
Covers spread with	
Staphylococcus pyogenes aureus.	No growth.
Bacillus anthracis.	No growth.
Bacillus diphtheriae.	No growth.
Staphylococcus pyog. aur.	concealed No growth.
Bacillus diphtheriae	by 4 layers No growth.
Bacillus of typhoid	of towel. No growth.

Test No. 2.—Room 3498 cubic feet, autoclave operated from the outside, one liter of formaldehyde solution used.

Test objects.	Exposure, 20 hours.
Covers spread with	
Bacillus diphtheriae.	No growth.
Bacillus of typhoid.	No growth.
Bacillus of plague or pest.	No growth.
Bacillus anthracis.	Growth.
Staphylococcus pyogenes aureus.	No growth.
Bacillus mallei	Growth.
Staphylococcus pyog. aur.	Growth.
Bacillus of typhoid	covered by Very faint growth.
Bacillus diphtheriae	five layers Very faint growth.
Bacillus anthracis	of towel. Growth.
Bacillus of pest	No growth.

In connection with these different tests, auxiliary observations are noted, illustrative of the various properties of formaldehyde and having direct bearing on its power as a disinfectant. Pieces of cloth stained with fuchsin were changed to a violet or purple color by exposure to the aldehyde. Egg albumin is slowly coagulated. Small cubes of gelatin are rendered insoluble in warm and hot water. When larger blocks of gelatin stained red by the addition of a few drops of fuchsin solution were cut open, the depth to which the change in color to violet or purple extended served as an indicator of the penetrating power of the aldehyde.

The gas as evolved is of an intensely irritating character, especially so to mucous membranes, yet when given an opportunity to escape, the room becomes habitable in a very short time. After the disinfection of rooms and apartments the atmosphere is now generally neutralized by means of ammonia vapor. Trillat⁴ and G. Roux found that guinea pigs exposed for twenty-four hours to a saturated atmosphere, neutralized as afore mentioned, suffered no ill effects.

An analysis of the air made in a room adjoining the largest one used in these experiments, gave a result of 2,600,000 bacteria to the cubic meter, while in the room of 3498 cubic feet, after an exposure of twenty hours (Generator No. 2), the examination revealed 1260 bacteria to the cubic meter. In the experiments of Trillat and Roux an analysis of the air showed a complete sterilization with the autoclave method, but a small number always retained their vitality after the use of the methylic-alcohol aldehyde generators. These same observers found that, in the examination of the dust, the samples collected from the walls gave no growth, while in the scrapings taken from the floor a certain number of bacteria developed after the use of either method. It was further noted that the larger collections of dust produced a cloudiness in bouillon sooner and more frequently than the

smaller or finer particles. Moist dust was also found to be more difficult to sterilize than when in the dry state, all of which tends to illustrate, to a certain extent, the penetrative power of formaldehyde.

The foregoing personal experiments seem to confine success in sterilization to superficial objects. Whenever an attempt was made at concealment of any degree, the result was in all instances negative. This agrees with the experience of Trillat and G. Roux, Bosc,⁵ Vaillard and Lemoine,⁶ Pfuhl⁷ and Ascoli. The results obtained are commensurate with the size of lamp or apparatus, that is, the amount of aldehyde gas generated and the size of the room. As to the amount of gas necessary for thorough sterilization this seems rather difficult to determine with any degree of exactness.

In generating the gas from methyl alcohol, Pfuhl has estimated the amount of wood alcohol to be used for every cubic meter as follows: bacillus of typhoid, sterilized by 47.1 grams; bacillus of diphtheria, sterilized by 21.2 grams; staphylococcus pyogenes aureus, sterilized by 62.8 grams; bacillus of anthrax spores, not by 94.1 grams; bacillus of tetanus spores, not by 94.1 grams. Taking these figures as a guide it would require not less than 2 liters of wood alcohol for 1000 cubic feet of space.

In the autoclave method where the 40 per cent. formaldehyde solution is used, Paul Struver⁸ places the required amount at 8.2 centimeters of formaldehyde (40 per cent.) for each cubic meter (35.28 cubic feet), while the Marine-Hospital Service Circular No. 121 fixes the same at 14.4 c.c. per cubic meter. With these standards accepted the negative results obtained in the above named tests would be explained.

The conclusions naturally drawn from the results must be that small generators or lamps, such as the No. 1 Hollister and others of similar type, are not adapted for room sterilization, and should be confined to use in very small areas of space. The No. 2 generator, having a capacity of 4 quarts of methyl alcohol, should only be used for room sterilization, and then I would place the limit at 2000 to 2500 cubic feet; if larger space is to be disinfected, more lamps should be added in proportion.

Articles in the room should be exposed freely, clothing spread about, pockets turned inside out, and all concealment avoided as much as possible.

The cheapness and the little attention required in producing formaldehyde gas from wood alcohol, renders this method very desirable, but the use of the several forms of apparatus so far proposed is attended by quite a number of defects, which are mainly due to the fact that the slow conversion of the alcohol allows the gas to escape through the many crevices and openings necessarily found in every room, before it has had an opportunity to penetrate into the depths of substances contained in the apartment. The latter difficulty is overcome to a certain extent by the autoclave method of generating the gas; the reports of its use are certainly more promising. The rather high cost of the apparatus will interfere somewhat with its general introduction, but by this method the gas escapes under a high pressure and in corresponding larger amount, the diffusion is more rapid and sterilization, in consequence, more complete.

In the recent able article of Doty,⁹ on "Disinfection by Steam," the virtues of this agent are brought forward most forcibly, corroborating what has been known heretofore of its effective power when used on

a smaller scale; and although here, also, expense enters as an important item, there can be no question that in penetrative power, rapidity of action and especially in the sterilization of linen, blankets, bedding, etc., steam can not be displaced by formaldehyde. All observers concede the superiority of formaldehyde gas over sulphurous oxid for room disinfection.

As a sterilizing agent for surgical purposes, an alcohol gas generator may be used, when confined to space not exceeding two and one-half cubic feet, and used for instruments only, with an exposure of at least thirty minutes, for I question the practicability of its use for sterilizing sheets, towels, gauzes or dressings of any kind. Used in solutions of 1 to 200, to 1 to 500 it forms a most efficient agent for the disinfection of instruments, and is superior to carbolic acid or corrosive sublimate, having no injurious effects, nor is it disagreeable to the hands of the operator. As a deodorant and disinfectant for general purposes, when used in solution, it has no equal.

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THE LIMITATIONS OF FORMALDEHYDE IN DISINFECTION.

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If formaldehyde or formic aldehyde is to be extensively used as a disinfectant, as now seems probable, it is important that the medical profession should know its limitations as well as its power, since either the use of a worthless disinfectant or the improper use of a valuable one is but little removed from a criminal act. Recent experiments indicate that only under certain conditions can we be reasonably sure of destroying pathogenic organisms by means of formaldehyde.

The compound is a gas of which the specific gravity is very nearly that of air. We should expect, therefore, that it would be slow to diffuse where air must be displaced. Pfuhl has shown (*Zeit. für Hygiene*, Vol. xxii, p. 339, Vol. xxiv, p. 289) that where it is present in sufficient quantities it sterilizes the surface of exposed objects, though its penetrating power is small. Similar results have been obtained by other experimenters. It is doubtful, then, whether it will replace other methods of disinfecting bedding, heavy clothing, etc. It has also been experimentally proven that a definite per cent. is necessary in the air to destroy bacterial life. Struver (*Zeit. für Hygiene*, Vol. xxv, p. 356) places this at 1.6 grams of the gas in 1 cubic meter of space. He has shown too that the ordinary type of lamp used for the generation of formaldehyde by the action of platinum on the vapor of wood alcohol converts only about 8 or 9 per cent. of the latter into formaldehyde (loc. cit.). If a lamp is used for the production of the gas, it must be large enough to furnish the required per cent. to the air of the room. Moreover, since the formaldehyde has the same specific gravity as the air, it will diffuse at the same rate as the air is driven out of the room through the cracks and other openings. In order to be most effective not only must a large amount be generated, but this must be quickly done to prevent diffusion