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NOTE ON THE VALUE OF MACERATION IN ETHER
AND IN ETHER-SOLUTION OF CORROSIVE
SUBLIMATE FOR THE STERILIZA-
TION OF CATGUT.

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PERHAPS there is no other article used in the consummation of aseptic and antiseptic operations of the present time upon which have been bestowed more time, care, and expense than the catgut for ligatures and sutures. In spite of its inherent dangers, it has not been displaced by other materials. Among recent methods for its sterilization, the most promising has been boiling in alcohol.¹ During a term as interne at St. Mary's General Hospital in Brooklyn, where this method was exclusively used, I was often impressed with the following marked disadvantages in the preparation of catgut by this method. The alcohol used must be absolute, or nearly so, and this can only be obtained for a certainty by securing it in the original package from some reliable manufacturer, and it is almost impossible to keep it absolute on account of its hygroscopic property. The necessity for a special apparatus is itself an objection. But the inherent danger of the method is its greatest drawback. I have several times seen an explosion occur even in this apparatus ;

¹ New York Medical Record, August 16, 1890. And in the same connection appears Dr. Charles N. Dowd's article, in which he very accurately describes an apparatus for use where this method is employed (New York Medical Record, December 3, 1893). In the same Journal, Dr. James O. Wilson refers to a more simple contrivance for those who do not possess the expensive and complicated apparatus of Dr. Dowd.

and it is a great disadvantage that some one must be always detailed to watch the process the whole time that the alcohol is boiling. There would have surely been serious damage done in the instances to which I have referred had not a nurse been near at hand to extinguish the flames. I have seen very poor practical results from this method, such as weak gut, when probably an inferior grade of alcohol has been unwittingly used. This must of necessity make it weak as the catgut absorbs the water. When once the catgut, thus prepared, has been removed from the original tubes in which it has been boiled, or has been in any other way exposed to possible infection, it is necessary that this painstaking method be repeated for another hour with the precautions above stated. Repeated boilings have a tendency to weaken the gut unless the same care to use absolute alcohol be adhered to.

It is my purpose to refer in detail to a method which possesses the prime advantage,—*i.e.*, simplicity,—no watching, no care, and no special apparatus,—and which is backed by results par excellence, as has been amply demonstrated by laboratory test, and a large clinical observation. I refer to that of Dr. John C. Schapps,¹ of this city, and subsequently modified. The commercial catgut in coils is placed in a wide-mouthed bottle with well-fitted glass stopper (what is known as a six-ounce, German XX salt-mouth is an economical size, as the internal diameter just permits the ordinary coil to lie flat) and completely immersed in stronger ether. The object of this step, the extraction of the fatty and other organic matter which would protect the microbes from the action of ordinary germicidal solutions, seems to be accomplished in forty-eight hours, but the catgut may be stored in ether for an unlimited time. When taken out it looks and feels remarkably clean, while the ether is more or less discolored and has acquired a distinctly animal odor. It is next wound on glass spools and placed in a small bottle containing an ethereal solution of mercuric bichloride one to one thousand, and there allowed to remain until used. According to the report given below it is sterile in five minutes.

Catgut is itself a devitalized animal tissue, and as ligature devitalizes, the objections to germicides do not apply as in the

¹ New York Medical Record of July 13, 1889.

case of living tissues, but the addition of a small amount of chemical germicide may be regarded as conservative. In other words, devitalized animal tissue is safer with than without the protection of a small amount of germicide.

To determine the effects of the ethereal solution and those of boiling and keeping in alcohol upon the tensile strength of the catgut, the following procedure was adopted: Five pieces were numbered. One, two, three, four, five, and each divided into thirds. One-third of each was left raw; one-third treated by boiling for one hour in 99.8 per cent. alcohol and left in the alcohol; the remaining third was placed in a one to one thousand

TESTS OF RAW CATGUT.

SPECIMENS.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Diameter . . . . .	.0208''	.0197''	.021''	.0221''	.0223''
Breaking Load	11.375 lbs.	16 lbs.	13 lbs.	14.5 lbs.	18.27 lbs.
Tensile Strength	33,475 lbs.	52,493 lbs.	37,528 lbs.	37,799 lbs.	46,774 lbs.

TESTS OF CATGUT BOILED AND SOAKED IN 99.8 PER CENT. ALCOHOL.

SPECIMENS.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Diameter . . . . .	.0208''	.0197''	.021''	.0221''	.0223''
Breaking Load	13.9 lbs.	15.7 lbs.	13.78 lbs.	11.62 lbs.	20.19 lbs.
Tensile Strength	40,906 lbs.	51,509 lbs.	39,780 lbs.	30,291 lbs.	51,689 lbs.

TESTS OF CATGUT SOAKED IN ETHER AND BICHLORIDE OF MERCURY.

SPECIMENS.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Diameter . . . . .	.0208''	.0197''	.021''	.0221''	.0223''
Breaking Load	12.22 lbs.	17.43 lbs.	11.72 lbs.	19.22 lbs.	15.59 lbs.
Tensile Strength	35,962 lbs.	57,185 lbs.	33,833 lbs.	26,642 lbs.	39,912 lbs.

solution of bichloride of mercury in commercial ether. At the end of one month tests were made at the Pratt Institute in this city to determine the tensile strength of each piece, each being divided, and so tested twice. In all thirty tests were made.

The tensile strength is the breaking strain per square inch

of section. The average of the raw catgut was 41,613.8 pounds; that of the alcohol boiled catgut 41,835 pounds; that of that treated with bichloride and ether 38,626.8 pounds. In other words, the catgut boiled in alcohol would seem to have acquired an increase of 0.5 per cent., and that treated with bichloride and ether a decrease of 7.4 per cent. The catgut in this instance was inadvertently prepared in commercial sulphuric ether, and its tensile strength, it is just to assume, was thus markedly lessened. If this diminution were constant, it would be so slight as to be practically of no account, but an examination of the table shows that the raw material has about as great a variation as this, and that the piece showing the greatest strength was one of those treated by ether and bichloride. Dr. Schapps has some that has been in solution for about three years, and it shows no perceptible diminution in strength. The inference is a fair one that the use of this method does not impair the strength of the catgut, and this inference has been abundantly borne out by clinical experience.

Dr. Louis C. Ager, assistant, Department of Bacteriology, Hoagland Laboratory, has, in compliance with my request, kindly made the bacteriological tests and reports as follows:

A number of pieces of catgut suture about one inch and a half long were sterilized in an Arnold sterilizer for half an hour. The catgut was medium size and came from the operating room of St. Mary's Hospital. These pieces were then soaked in an old sporulating culture of bacillus anthracis for twenty-four hours. One of them was dropped into a tube of sterile beef-tea and the others were put into a solution of bichloride of mercury, gr. $\frac{1}{4}$, to ether sulph., oz. $\frac{1}{2}$,—(*i.e.*, 1 : 960). They were next removed at intervals of 5, 10, 20, 30, and 60 minutes, washed in sterile water to remove the bichloride and dropped into tubes of sterile beef-tea. After sixty hours in the incubator there was a prolific growth in the control tube, but the others remained sterile. In order to ascertain whether enough bichloride had been carried over to inhibit the growth of live germs, all the tubes were inoculated with anthrax. After forty-eight hours in the incubator there was a growth in each tube. This experiment is, on the whole, satisfactory. It seems to show that five minutes in an ether solution of bichloride of mercury, 1 : 1000,

is sufficient to sterilize catgut. Still, there are certain possibilities of error to be considered. The growth after the second inoculation was not as prolific as was to be expected, showing that a certain amount of bichloride was present. As Gefferts has shown that even 1 : 2,000,000 bichloride solution will prevent the development of anthrax spores, the vitality of which has been lowered by a strong solution, it is not impossible that there were living spores in the catgut. But, if there was a sufficient deposit of bichloride of mercury about them to prevent their development, they need not be considered.

A somewhat extensive use of catgut thus prepared has served to verify clinically these findings. In no case of operation in healthy tissues has suppuration occurred. The absence of stitch abscesses when the catgut is used is evidence to prove that the amount of mercuric bichloride incorporated into it is not enough to interfere with the vitality of the tissues with which it comes in contact, and if there are any germs present they do not declare themselves sufficiently to mar the gratifying effect of the method. The catgut so prepared ties with a good, firm knot.

Some of the most prominent of the advantages of this method are: When the catgut becomes in any way infected, simple replacement in the solution renders it soon again ready for use. Ether cannot be diluted with water, and if it evaporates, a supply is usually at hand. Should the surgeon at any time, in case of emergency, find himself without a supply of reliable catgut, what could be easier than simply to immerse the raw catgut in the ethereal bichloride solution, which could be done while other preparations for the operation were being executed? This has been shown by the foregoing experiments to be sufficient without the preliminary washing in ether. The catgut does not look nor feel as clean, however. The precautions to be taken when this plan is in vogue are that the catgut, when taken out of the solution and not used, is not in any way brought in contact with aqueous solutions as it will become softened, and when again replaced in the ethereal solution does not regain its former strength. If the ether evaporates, it, and not a solution of bichloride, should be added. As the commercial sulphuric ether

contains alcohol, it is essential that stronger ether be used. Otherwise, as the ether evaporates the alcohol will absorb water from the air. When the glass stoppers do not fit accurately, as is frequently the case, they may be refitted at a nominal expense. It is also a simple but valuable precaution, whenever volatile substances are to be enclosed, to put with a small file corresponding marks upon each bottle and its stopper. When the ether has become so contaminated as to leave a grease-spot where it touches the sides of the bottle, it must be replaced by fresh. It is available for a first bath, fresh ether being used for a second.

Catgut prepared by means of commercial sulphuric ether, when exposed to the air, is moist, shiny, and soft, but when stronger ether is used, it remains stiff and hard.

It soon becomes pliable by absorption of moisture, but clinical experience demonstrates that it does not break down too soon.

I know of no reason why the same treatment may not be used for other styles of suture material, as silk-worm gut.