An evaluation of agents used in cavity sterilization

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Introduction

The intention of this paper is twofold, namely, to review briefly the vexing problem of dentine cavity sterilization and to report on the effectiveness of chemical and antibiotic agents that are commonly used for sterilizing a cavity.

In spite of the painstaking efforts of some of the profession's best researchers in this field—Hardwick, Seltzer, Nuckolls, Bodecker, Bartels, Zander, Stephan, Besic, and others—the answer to the posed question, "Are the available methods of cavity sterilization, with such agents as silver nitrate and phenol, purely empirical procedures?" is a definite yes.

The men on whose research the answer is based still do not entirely agree that sterilization of dentine after cavity preparation is necessary. However, those in favour of cavity sterilization seem to be in the majority, and it will be the purpose of this paper to present their views.

Why sterilize dentine after cavity preparation?

The basis for dentine sterilization depends upon whether or not there is a need for such a procedure. It is therefore imperative that a review of the histologic structure of dentine and the carious process be included in this paper.

There are two current views concerning the advance of bacteria through the dentine during the carious process. W. D. Miller[1] and G. V. Black[2] believed that the solution of calcium salts and the softening of the dentine preceded bacterial invasion. This view is supported by the fact that there is often a bacteria-free layer beneath the superficial layer of necrotic dentine.[3]

Howe[4] and Kronfeld[5] believed that invasion of the dentinal tubules precedes decalcification of the surrounding matrix. G. V. Black himself was among the first to demonstrate the presence of bacteria within the dentinal tubules in advance of the carious lesion.[2] Kronfeld showed in histologic sections that the pulp is often invaded by microorganisms long before it is actually exposed by caries.[5] Zander says that two forms of caries exist, as demonstrated by Harazawa in 1923.[6] In the acute, rapidly penetrating form, often seen in children, decalcification precedes bacterial invasion, rendering the dentine sterile in advance of the necrotic layer. In the more prevalent chronic form, bacteria penetrate more deeply into the dentinal tubules before the matrix is softened.

Perhaps this difference of opinion may be due to the possibility that, in histologic section, one cannot tell exactly where the natural decalcification of caries ends and the artificial decalcification produced in histologic preparations begins. Therefore, several clinical tests have been executed concerning the

Received for publication September, 1961.

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(1) Miller, W. D.—The micro-organisms of the human mouth. Phila., The S. S. White dental mfg. Co., 1890 (pp. 179-180).

(2) Black, G. V.—Vol. 1, Operative dentistry. Chicago, Medico-dental Publishing Co., 4th ed., 1920 (pp. 70-71).

(3) Dorfman, A., Stephan, R. M., and Muntz, J. A.—In vitro studies on sterilization of carious dentin. II. Extent of infection in carious lesions. J.A.D.A., 30: 1901-1904 (Dec.) 1943.

(4) Howe, P. R.—A method of sterilizing, and at the same time impregnating with metal, affected dentinal tissue. D. Cosmos, 59: 891 (Sept.) 1917.

(5) Kronfeld, R.—Histopathology of the teeth. Phila., Lea & Febiger, 4th ed., 1955 (p. 144).

(6) Zander, H. A.—Bacteria in the dentin after cavity preparation. Illinois D. J., 9: 207 (March) 1940.

sepsis of dentine after cavity preparation to provide the basis for the practitioner's use of cavity sterilization procedures.

Examination of carious dentine, *in vitro* or *in vivo*, reveals that three layers can be distinguished clinically. There is first a thick layer of soft, discoloured and necrotic dentine often mixed with food debris. This layer teems with bacteria. The dentinal tubules and the protoplasmic extensions from the odontoblasts are destroyed.

Under the superficial necrotic layer of dentine there is a harder, softened dentine, usually discoloured brown. This layer of softened, brown dentine can be separated from the underlying hard dentine. The tubular structure and the odontoblastic processes are still intact, and pain sensations are transmitted to the pulp.

In acute caries or in early chronic caries, few, if any, bacteria are present in this second layer. In later stages of chronic caries and in arrested caries it always contains many micro-organisms. In addition to having many bacteria, the first two stages of caries have affected the dentine in the second layer by degeneration of the tubular structure and odontoblastic processes.

Under the second layer of carious dentine there lies a hard, presumably sound dentine. Often (especially under deep and chronic carious lesions) this third layer is discoloured, but it is hard and very painful, indicating the presence of viable protoplasmic processes from the odontoblasts. This layer constitutes the cavity floor in deep and moderately deep cavity preparations, and is the dentine with which practitioners must be concerned in regard to sterilization.

In Dorfman's summary on the extent of infection in carious lesions he wrote:

> "The extent of infection in carious lesions was determined by culturing samples of dentin taken at various levels of freshly extracted teeth. Two methods of sampling were used: (*a*) starting on the carious dentin and going to sound dentin and (*b*) starting in sound dentin and going into carious dentin. It was found that the superficial layers of carious dentin were always infected, that intermediate layers were sometimes infected, and that the partially decalcified dentin adjacent to sound dentine and the sound dentin were almost always sterile. These findings are of importance in planning operative procedure for the treatment of deep carious lesions." [7]

According to Dorfman, cavity sterilization becomes unnecessary when all visible decay is removed. It is our belief that this is a valid result, but it must be remembered that this was an *in vitro* study. Further, in view of this fact I believe that the average practitioner cannot be sure he has removed all decay, especially in deep lesions, and that *in situ* studies might provide more information on the necessity of cavity sterilization.

Evidence resulting from research done by Zander and Seltzer, independently, seems to indicate that during the carious process a few "pioneer" bacteria infiltrate through the dentinal tubules. Zander studied ten teeth in which the carious lesion did not involve the pulp. He prepared the cavities in these teeth under aseptic conditions and removed all apparent decay. The teeth were then extracted and histologic sections prepared following decalcification. Microorganisms were observed in the hard dentine of four teeth (40 per cent of the total) at a distance of 0·8 mm. to 1·2 mm. beneath the cavity floor. Zander concludes that theoretically it is possible for facultative anaerobes to survive and multiply in the dentine beneath filling materials.[6]

Probably the most extensive study involving research in regard to dentine sepsis was performed by Seltzer. He prepared occlusal cavities, with which he was assured of obtaining a good cavity seal, using a sterile technique. Extreme care was taken in removing all carious material that could be observed clinically, and the preparation was extended exactly as it would be for insertion of a metallic restoration. As soon as the cavities were ready for filling, but prior to the introduction of any medicament, shavings were cultured in Rosenow's brain broth from 72 shallow cavities, 113 medium cavities, and 49 deep cavities. The conclusions drawn were that the chances for mechanically eliminating all bacteria from a shallow cavity were slightly greater than 50 per cent. In cavities of medium depth the results were 84·0 per cent

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[7] Dorfman, A., Stephan, R. M., and Muntz, J. A.—*op. cit.*

positive, while in deep cavities the results were 93·8 per cent positive.[8]

Massler states:

> "These data, plus histologic evidence, indicate that bacteria are usually present in advance of the carious lesion and in the dentin under the base of even carefully prepared cavities—especially under medium and deep cavities." [9]

The possibility of recurrence of decay due to bacteria left under fillings cannot be overlooked.

We believe the evidence stated above indicates to the practitioner that cavity asepsis is not complete after preparation. Since it is the purpose of dentists to remove caries and thus save the teeth, it must be realized that mechanical preparation, in many instances, leaves the cause of caries in the dentine.

Fate of bacteria under restorations

Before advancing to the evaluation of sterilizing agents, it is necessary to investigate the fate of bacteria sealed in the dentine under restorations. Obviously, if the bacteria do not remain viable under the restoration, then sterilization is not necessary. However, if the bacteria remain viable, then the possibility of their growth cannot be overlooked.

The most extensive study regarding this problem was carried out by Besic. He used only molar teeth with occlusal cavities so that a good marginal seal could be obtained. No antiseptics of any kind were ever used in the prepared cavities. The following procedure was employed by Besic in conducting his experiment:

Rubber dam was applied to isolate the tooth in question and the area sterilized (cavity in tooth not touched by antiseptics). All undermined enamel was chipped away and all decay at the dentino-enamel junction was completely removed; a small amount of decayed dentine was allowed to remain in the base of the cavity in all but a few cases. Since it is believed that most operators will usually leave small traces of decayed dentine in extensive cavities, it seemed advisable to do the same in most cases. By allowing decay to remain in the base of a cavity and noting its progress over a period of a year or more, one could substantiate or question the theory of necessity of complete eradication of softened dentine.

Cultures were taken of the cavity and placed in various media which were selective in supporting growth of different organisms. Microscopic slides of all growths were made and studied after staining by Gram's method.

The cavity was wiped dry with cotton pellets. A portion of a dry pellet was left in the cavity and covered first with sterile gutta-percha packed down tightly and that in turn covered by oxyphosphate zinc cement. Thus the decayed or contaminated portion of the cavity came in contact only with the cotton and the bland sterile gutta-percha. This prevented any action of the cement on the bacteria in the cavity and also furnished a double seal.

The tooth was left in this condition for two weeks. The cavity was then opened and material obtained for culture. A third culture was made in two more weeks and successive cultures at various intervals for a period as long as a year and a half in some instances.[10]

Besic found out that (*a*) the carious process definitely stops or gradually ceases as soon as the lesion is closed from the oral environment, even when the bacteria remain alive; (*b*) the bacteria have a tendency to die out; (*c*) in 30 per cent of the cases studied positive cultures of streptococci persisted after being sealed for more than one year.

Both Besic and Kraus stressed the fact that the restoration must be hermetically sealed so that saliva and food do not become available for bacterial growth.[10][11] Since many filling materials do not satisfy this requirement and do permit ingress of particulate matter along their margins,[12] the incidence of recurrent decay may be much higher than we are willing to admit. A study of this problem should be most revealing:

Massler expresses our opinion:

> "At the present time it would be logical to conclude that it would be better to sterilize the dentin if this could be done effectively and without pulpal injury

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[8] Seltzer, S.—Bacteriologic status of dentin after cavity preparation. J.A.D.A., 27 : 1799 (Nov.) 1940.

[9] Massler, M.—Sterilization of dentin. J. Tennessee D. A., 35 : 375-392 (Oct.) 1955.

[10] Besic, F. C.—Fate of bacteria sealed in dental cavities. J. D. Res., 22 : 349-354 (Oct.) 1943.

[11] Kraus, A.—Untersuchungen über das Verbalten der Saeurbildner in Dentin unter Phosphotzement und Doublienrten Fuellemgen. Zeitschrift f. Stomatologie, 31 : 162, 1933.

[12] Armstrong, W. D., and Simon, W. J.—Penetration of radio-calcium at the margins of filling materials. J.A.D.A., 43 : 684-686 (Dec.) 1951.

rather than to depend upon the hermetic seal of the average filling and the tendency of bacteria to die out (if the marginal seal remains intact), over a period of ten to eighteen months." (9)

Evaluation of drugs used in dentine sterilization

Alcohol

Both 75 per cent and 95 per cent solutions of alcohol have been used extensively in dental practice for cavity toilet. Presumably they were used to sterilize the cavity. Evidence, however, points to the contrary and shows that alcohol has no value as a germicidal agent in cavity sterilization.(13) In fact, alcohol used as a solvent for phenol and thymol reduces their germicidal properties. In reference to cavity sterilization, Appleton explicitly states that "every addition of ethyl or methyl alcohol to an aqueous solution of phenol or formic aldehyde decreases its disinfectant action".(14)

This action of alcohol is believed to be due to its coagulating property which prevents more than superficial contact with the bacteria.(15) Furthermore, the use of alcohol for sterilizing a cavity produces pulpal irritation and pain.

Eugenol and zinc oxide-eugenol

Eugenol is a potent germicide which is palliative to the pulp when applied over short or long periods of time.(9) Turkheim has shown that zinc oxide and eugenol was the only filling material effective in inhibiting bacterial growth *in vitro* over a long period of time.(16) Further, he showed in actual tests *in vitro* that zinc oxide and eugenol did, in fact, completely sterilize infected slabs of dentine 1 mm. thick after contact with the dentine for twenty-four to forty-eight hours.(17)

Since sterilization of the dentine would have no value if pulp injury occurred as a result of the sterilization, zinc oxide and eugenol seems a superior medicament, since it can soothe the recently injured and inflamed pulp and can effectively sterilize the underlying dentine and residual decay in deep carious lesions.

Zinc ferrocyanide

This agent was first advocated by Gottlieb, but the method of administration has been revised by Muller and Maeglin.(18) A solution of 40 per cent $ZnCl_2$ and a solution of 20 per cent $K_4Fe(CN)_6$ are introduced into the cavity with cotton pellets. A finely dispersed white precipitate of $Zn_2Fe(CN)_6$ is formed, which impregnates the tubuli so that they are impenetrable to chemical influences.

The zinc ferrocyanide formed causes an efficient impregnation resulting in the closure of the dentinal tubules. Zinc ferrocyanide also has a disinfecting component capable of sterilizing the dentine.

According to Muller and Maeglin,(18) histological investigations in which dentine has been treated with this precipitate demonstrate the harmlessness of the medicament, even in those cavities situated close to the pulp.

Thymol

Thymol, one of the essential oils, is obtained from the plant *Thymus vulgaris* and from synthetic sources. It occurs in large, colourless, rhombic prisms which have an aromatic odour and taste. The melting point of the crystals is 51·5° C., which is important to note, because it is the melted crystals which are used for cavity sterilization.

Results from using pure cultures of lactobacilli show that thymol is 23·4 times more germicidal than phenol.(19) Phenol, with relatively no antiseptic properties, will burn delicate tooth structure, whereas thymol will not burn and its action is not self-limiting. A few crystals left in the dentine will sterilize indefinitely.(19)

Bacteriological studies have revealed that thymol penetration results in a definite sterilization of decay. Therefore, if pulp involvement seems probable, roentgenographically if not clinically, small amounts of thymol can be left near the pulp. In this way, the pulp is not involved through mechanical exposure,

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(13) Seltzer, S.—The comparative value of various medicaments in cavity sterilization. J.A.D.A., 28 : 1844-1852 (Nov.) 1941.

(14) Appleton, J. L. T., and Bryant, C. K.—Laboratory guide to bacteriology. Phila., Lea & Febiger, 1928 (p. 38).

(15) Andrews, J. E.—Cavity sterilization. Georgetown D. J., 11 · 77-81, 88 (Feb.) 1943.

(16) Turkheim, H. S.—Bacteriological investigations on dental filling materials. Brit. D. J., 95 : 1-7 (July 7) 1953.

(17) Turkheim, H. S.—In vitro experiments on the bactericidal effect of zinc oxide eugenol cement on bacteria-containing dentin. J. D. Res., 34 : 295-301 (Apr.) 1955.

(18) Müller, O., and Maeglen, G.—Sterilization of dentin on vital teeth. Internat. D. J., 3 : 170-171 (Dec.) 1952.

(19) Day, H. W.—Thymol in cavity sterilization. J.A.D.A., 31 : 605-615 (May) 1944.

nor is the odontoblastic layer broken to retard the regeneration of secondary dentine.

Pure liquid thymol should be used because the alcoholic solution lessens the germicidal properties of thymol. Thymol is good for all cavity sterilization but is best suited for anterior teeth because it causes no discolouration. If the liquid is blown out of the cavity by warm air, a few crystals will remain in the porous dentine, but the cavo-surface margins will be free.

Phenol

Phenol and phenol components have been used extensively for cavity sterilization. Apparently most users of phenol have not investigated its actions and results, but rather have applied this medicament traditionally.

In the past, the action of phenol on the protein of dentinal fibrils was considered to be self-limiting. However, Thomas concluded that phenol does penetrate tooth structure and is not self-limiting as a result of its activity in organic matter.[20] Stephen showed that there was little or no penetration of 95 per cent phenol into carious dentine.[21] From the biochemical standpoint, phenol denaturizes protein and forms a precipitate. Thus, the phenol is used up and no further reaction can take place. In effect phenol appears to be good only for sterilizing the surface, since it cannot penetrate carious dentine deeply enough to be effective. Its use in deep cavity preparations is prohibited because of its toxicity to the pulp.

In addition to being ineffective for cavity sterilization and toxic to the dental pulp, the use of this agent is also questionable because of its escharotic effect on the soft tissues if accidentally applied. Most investigators have indicated that phenol is contraindicated for cavity sterilization.

Silver Nitrate

As early as 1846 the value of silver nitrate was recognized. However, clinical observations following treatment with silver nitrate were first reported by Stebbins in 1891. Silver nitrate has been used extensively for over a hundred years as a measure for prohibiting caries in the young and for sterilizing the cavity. During this period many investigators have reported on its effects and action.

Howe's introduction of ammoniacal silver nitrate in 1917 is considered the beginning of a renaissance in the clinical use of silver nitrate.[22] The addition of ammonium hydroxide to a silver nitrate solution converts the latter from an acidic, irritating solution to an alkaline solution with practically no irritating action.

The chief advantage to be obtained from the use of Howe's Solution is its ability to sterilize disintegrated dentinal structure and to neutralize the acid reaction of dental caries. Sterilization results from the actions of the metallic silver upon the proteins of the bacteria in the decayed tooth structure, which are precipitated and thus prevented from further action. Neutralization of the acid reaction of dental caries is accomplished by the alkaline reaction of Howe's Solution, which, if prepared propertly and applied fresh, is slightly alkaline, having a pH of 8·5 to 9·5.[23]

The inhibitory action of silver nitrate is lost if it is not reduced. The use of eugenol for this purpose is recommended because the reduction with eugenol leaves the pH on the alkaline side and reduction is more nearly complete.

Silver nitrate, both a caustic and a protein coagulant, has given rise to the belief that it is a self-limiting drug. Work has been done by several investigators to determine its penetrating abilities in carious tooth structure and in sound tooth structure. One group of investigators used a special apparatus which permitted determination of the depth of sterilization produced by germicides in carious lesions of extracted teeth. It was found that a saturated solution of silver nitrate penetrated carious dentine to an average of 0·3 mm. by a one-minute application, 0·7 mm. by a three-minute application and 1·3 mm. by a ten-minute application. Howe's Solution was slightly less effective.[21] These results make it evident that sterilization of infected dentine in carious lesions is possible with a saturated silver nitrate solution, but only if an adequate

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(20) Thomas, B. O. A.—Penetration of phenol in tooth structure. J. D. Res., 20 : 435-445 (Oct.) 1941.

(21) Dorfman, A., Stephan, R. M., and Muntz, J. A.—In vitro studies on sterilization of carious dentin. III. Effective penetration of germicides into carious lesions. J.A.D.A., 30 : 1905-1908 (Dec.) 1943.

(22) Howe, P. R.—*op cit.*

(23) Graham, F. W.—Silver nitrate and zinc oxide in the treatment of children's teeth. J.A.D.A., 28 : 124-128 (Jan.) 1941.

procedure is followed. The time of application is all important.

Penetration of silver nitrate into dentine has been shown to occur by many investigators, but how this penetration proceeds is a moot point. Some investigators say the silver nitrate is carried through the dentine by the dental lymph, while others support the theory that the precipitation product proceeds through the dentine by following physical laws governing the progress of fluid through capillary channels. The answer to the problem was found by comparing the penetration of silver nitrate into sound dentine, into degenerated dentine of vital teeth, and into dentine of teeth without vital pulps.

In the experiment done by Zander and Smith there was no evidence that the silver nitrate depends upon the circulation of the dental lymph to be carried through the dentine.[24] It was proposed that such phenomena as capillary attraction, diffusion, and differences in pressures may explain the penetration. One of the most important findings of this experiment was that the depth. of penetration increases as time goes on and may, and often does, reach the dental pulp.

It has been shown that silver nitrate does penetrate dentine to a degree sufficient for sterilization, but the question is posed. "Does depth of penetration equal depth of sterilization?". In a carefully controlled experiment carried out by Muntz and associates this problem was investigated.[25] It was found that a three-minute application uniformly sterilized at least 0·25 mm. of carious dentine and that the average silver concentration required to do this is 230 parts of silver per thousand parts of dentine. In approximately half of the experiments a three-minute application sterilized to a depth of 0·5 mm.

In ten minutes' application the depth of sterilization was increased to 0·75 mm. in most cases, and at this depth the average silver content was 106 parts of silver per thousand parts of dentine. At greater depths, sterilization resulted less frequently.

The question of pulpal damage must be considered. Does or does not silver nitrate cause irreversible pulpal damage if it comes in contact with the pulp? In a study by Perreault various medicaments were placed in dental cavities prepared in incisors of rats and the effect on the dental pulp was studied. He found that silver nitrate produced destructive reactions in the pulp even when applied for only one to three minutes. Silver nitrate produced hypoplasia even in shallow cavities and complete death of cells and pulpal necrosis under medium and deep cavities.[26]

In contrast to the above findings, other investigators have concluded that silver nitrate is not injurious to the pulp. The studies of Zander, Prime, Seltzer and Werther, and others, demonstrates that there is no harmful effect on the pulp if there is the least amount of sound dentine between the carious area and the pulp. If no sound dentine is present, the silver nitrate will penetrate to the pulp and coagulate the albumin by its escharotic effect, causing pain and pulpal necrosis.[27]

The use of silver nitrate for cavity sterilization is one of the most controversial points of cavity sterilization. It has been shown by most investigators to be effective, but there is substantial evidence contra-indicating its use. It will be necessary to repeat the application of silver nitrate to cavities prepared in human teeth and to study the histologic effects more carefully before more definite conclusions can be drawn.

Antibiotic cement

In the previous discussion, it has been pointed out that chemical sterilization of the dentine cavity is inadequate for two reasons: unsuccessful stoppage of bacterial growth and injurious effect upon the protoplasmic contents of the dentine tubuli and the pulp.

To overcome the disadvantages of chemical sterilization, Stephan has suggested the use of antibiotics because of their penetrability and lack of irritation.[28]

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[24] Zander, H. A., and Smith, H. W.—Penetration of silver nitrate into dentin. J. D. Res., 24: 121-128 (June-Aug.) 1945.

[25] Dorfman, A., Stephan, R. M., and Muntz, J. A.—In vitro studies on sterilization of carious dentin. I. Evaluation of germicides. J.A.D.A., 30: 1893-1900 (Dec.) 1943.

[26] Perreault, J. G.—Effects of drugs placed in cavities prepared in the incisor of the albino rat. Thesis, University of Illinois, College of Dentistry (June) 1955.

[27] Rabinowitch, B. Z.—Ammoniacal silver nitrate: a study of its value in operative dentistry today. J. Den. Children, 18: 22-30 (2nd quarter) 1951.

[28] Stephan, R. M.—Consultant Symposium: Our empiric cavity sterilization. Part III (and discussion). N.Y. State D. J., 17: 185-189 (May) 1951.

Colton and Ehrlich have shown that the addition of antibiotics, and particularly polyantibiotics, increased the bactericidal effectiveness of dental cements.[29] Polyantibiotics added to dental cements increase their bactericidal effectiveness in the semifluid state and persist long after complete setting and after multiple transfers.

Further *in vivo* tests using lithium cement and ABC polyantibiotic cement for cavity sterilization were conducted by Colton and Ehrlich.

> "Permanent teeth only were selected for the test because of the difficulty of employing the rubber dam on deciduous teeth. In every instance where multiple cavities were prepared for the same patient, the deeper or more extensive cavity was filled with polyantibiotic cement.
>
> Where depth of decay threatened exposure if completely removed, some decay was maintained over the pulpal wall. In every instance polyantibiotic cement was used for filling.
>
> Where the pulp was exposed the tooth was eliminated from the experiment.
>
> Results: of 210 teeth filled with lithium cement 186 showed positive growths of organisms before filling, 24 were negative and eliminated from further consideration.
>
> Of the 208 teeth filled with polyantibiotic cement 194 showed positive growths of organisms before filling, 14 were negative and eliminated from further consideration.
>
> Cultures after removal of fillings: of the 186 teeth showing positive growths before filling with lithium cement, 159 showed positive growths and 27 showed no growths.
>
> Of the 194 teeth showing positive growths before filling with polyantibiotic cement, 12 showed positive growths after removal of filling and 182 showed no growths.
>
> Lithium cement:
>
> 87 per cent non-sterile on removal of filling.
>
> 13 per cent sterile on removal of filling.
>
> Polyantibiotic cement:
>
> 7 per cent non-sterile on removal of filling.
>
> 93 per cent sterile on removal of filling." [30]

Another group of investigators employed the use of a combination of penicillin and parachlorophenol in attempting to sterilize carious dentine.[31] This combination was used for the following reasons: both drugs are tissue-tolerant; penicillin is effective against gram-positive bacteria, while camphorated parachlorophenol is effective against both gram-positive and gram-negative organisms, including yeasts.

The purpose of their experiment was to determine whether infected dentine could be sterilized, and, if this could be accomplished, then to determine whether the bacterial activity could be reduced to a point where the natural body defences could take care of the remaining bacteria.

> "After the teeth in question were isolated and cleaned of all gross debris and superficial caries the drug mixture was placed over the remaining caries after shavings from the floor of the cavity were cultured.
>
> The drug mixture was made by placing a 50,000 unit tablet of soluble penicillin G on a sterile slab and mixing with enough camphorated parachlorophenol to make a stiff, dry paste.
>
> At the second visit, the middle layer of carious dentin was removed and cultured. The same treatment technique was followed as described for the first visit.
>
> At the third visit the innermost layer of carious dentin was removed and cultured. Caution was exercised not to expose the pulp. The drugs are again sealed in and left permanently.
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> Results were encouraging. Seventy-five per cent of the cavities were rendered sterile after the third visit. When roentgenographic and clinical findings were considered the success of the treat-

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[29] Colton, M. B., and Ehrlich, Eugene.—Bactericidal effect obtained by addition of antibiotics to dental cements and direct filling resins. J.A.D.A., 47: 524-531 (Nov.) 1953.

[30] Colton, M. B., and Ehrlich, Eugene.—Polyantibiotic dental cement as a cavity sterilant. In vitro and in vivo report. N.Y. State D. J., 23: 23-30 (Jan.) 1957.

[31] Burkman, N. W., Schmidt, H. S., and Crowley, Mary C.—Preliminary report of an investigation to study the effectiveness of certain drugs for sterilizing carious dentine. Oral Surg., Oral Med. & Oral Path., 7: 647-657 (June) 1954.

ments was 93 per cent. The teeth showed improved response to vitalometric tests and those teeth that had periapical changes show either normal tissue or beginning repair about the apex." (31)

After completing this preliminary report Burkman *et al.* continued their investigations. In order to simulate clinical conditions only one application of the drugs was made after removing as much caries as possible without exposing the pulp.(32)

The same methods of tooth isolation, culturing, and drug application were observed after treatment:(32)

1. The dentine became dehydrated and firm.
2. Vitalometric tests were generally improved.
3. Roentgenographically, many teeth showed periapical areas indicative of early inflammatory changes returned to normal.
4. There was a limited formation of reparative dentin.

The bacteriological results over a six-year period are summarized in Table 1. A total of 146 teeth were treated. Of these, 87 per cent were sterile after one to three treatments.(32)

TABLE 1.

Summary of bacteriologic results for six years.

Year.	Number of teeth treated.	Number negative after 1–3 treatments.	Number positive after 3 treatments.	Percent. negative after 3 treatments.
1952–53 ..	44	33	11	75
1953–54 ..	20	18	2	90
1954–55 ..	31	27	4	87
1955–56 ..	18	16	2	88
1956–57 ..	12	12	0	100
1957–58 ..	21	21	0	100
Total	146	127	19	87

Table 2 shows the bacteriologic results after removal of as much carious dentine as possible in one operation without exposing the pulp. Thirty-three teeth were treated. Of these, 79 per cent were negative after one treatment, and none was positive after three treatments.(32)

The studies by various investigators presented in the preceding discussion on the efficacy of antibiotics for cavity sterilization have extraordinary appeal to the dental profession. Based on the findings of the investigators this method offers a way to halt the carious process and repair the involved pulp chemotherapeutically.

Studies in this phase of cavity sterilization need to be pursued further to determine what the effect will be on the tooth medicated. The depth of effective sterilization needs to be determined. Another important point to investigate is whether the aging process of the tooth is accelerated. Finally, microscopic examination of the treated teeth is needed to determine the histopathologic effect of the drugs, and whether the results from these investigations support the use of this procedure.

TABLE 2.

Bacteriologic results after removal of as much carious dentine as possible in one operation.

Number of teeth treated.	Number negative after 1 treatment.	Number negative after 2 treatments.	Number negative after 3 treatments.
33	26 (79%)	6 (18%)	1 (3%)

Conclusion

Although cavity sterilization cannot be overlooked, the methods used to accomplish cavity sterilization are controversial. The study of the effect of sterilizing agents on deep-seated cavities presents many difficulties. Teeth that have deep carious lesions are usually so broken down that the maintenance of a sterile field becomes difficult. The procurement of teeth for histologic sectioning after treatment presents another problem. Human teeth present a wide variety of pulpal conditions and reactions because of the patient's age, previous injury by caries, trauma, and operative procedures. Thus the effect of a medicament on the pulp presents a confusing picture which is difficult to evaluate correctly.

Sterilizing agents react in one or more of the following ways:

1. By coagulation of proteins.
2. By poisoning some essential enzyme substrate within the organisms.
3. By causing bacteria to lose proteins and electrolytes to the surrounding medium.

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(32) Schmidt, H. S., Crowley, M. C., Harner, V., and Burkman, N. W.—Bacteriologic report of an investigation to study in vivo the effectiveness of certain drugs for the sterilization of carious dentine. Oral Surg., Oral Med. & Oral Path., 13 : 80-88 (Jan.) 1960.

> A profound alteration in the permeability of the cell membrane results and prevents the organism from maintaining equilibrium with its environment.[33]

A final conclusion on the efficacy of antibiotics for sterilizing cavities would be invalid at the present time.

Ideally, antibiotic therapy offers the greatest promise for cavity sterilization as it treats the infection by administration of certain cellular products and/or chemicals which affect the causative organisms unfavourably but do not injure living tissue.

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[33] Davis, H. L.—Introduction. Ann. New York Acad. Sciences, 53 : 3-5 (Aug.) 1950.

It is impossible to stop hypochondriasis altogether. The hysterics who unconsciously benefit by it will achieve their object whatever the difficulties and as long as people continue to be born with an inherent predilection towards hypochondriasis, the disease will continue, because such people provide soil in which the puniest seed may develop into a mature plant. Yet much could be done to lessen the incidence of hypochondriasis (or to be more accurate and less hopeful—much ought to be done) by reducing the indiscriminate farrago of seeds and spores which, from a thousand sources, is being scattered far and wide through air and aether. The most prolific source of this seed, the only one at present increasing its output yearly and whose seeds sprout their weedy growths in the shallowest of soil, is television.

Print no longer holds its former power. A better educated public after years of printed misinformation, has become partly immunized; today one rarely hears, "It must be true—I saw it in print." A more powerful new delusion is beginning to replace the old: "It must be good, I saw it on the Telly." The living screen brings voice, personality, expression, gestures—all the most influential powers in human relationship—right into he front parlour and a few seconds of sound and vision can do more than a whole column of print to sow the seeds of hypochondriasis.—*Richard Asher, New Scientist, June 22, 1961.*