TREATMENT OF OSTEOMYELITIS AND INFECTED WOUNDS BY CLOSED IRRIGATION WITH A DETERGENT-ANTIBIOTIC SOLUTION

By

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Topical treatment of osteomyelitis and infected wounds, including old ununited fractures, has proved to be successful in a high percentage of cases, including those in which the bacterial organism was resistant to most antibiotics. Treatment by means of continuous irrigation (or circulation) and suction of the closed wound, using a solution containing an antibiotic and a detergent, has evolved from theory and trial and error within the last five years.

In 1942 *Brantigan & Owens* (1) reported the topical use of sodium tetradecyl sulfate in the treatment of acute pyogenic empyema of the pleural cavity. This detergent, or "wetting agent", is a non-specific germicide which proved to be an effective solvent of sputum and empyema fluid. There was evidence that it penetrated infected and necrotic tissue. *Jeffrey* (2) had observed that penicillin not infrequently did fail, even against susceptible organisms "in necrotic soft tissue and necrotic bone and in the center of abscesses and masses of fibrinopurulent material".

Grace & Bryson (3) in 1945 reported success in the topical use (in three cases of chronic osteomyelitis) of penicillin in a solution of isotonic sodium chloride with 0.1 per cent of the detergent sodium tetradecyl sulfate.

In 1947 *Grace & Bryson* (4) reported excellent results following the topical use of a penicillin-detergent solution in treating two war veterans who had been discharged from military service with "intractable"

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osteomyelitis. In this same report they referred to their success in treating a series of 37 civilian patients who were suffering from chronic osteomyelitis.

During the decade following his first successful use of a detergent-antibiotic solution, *Grace* and his co-workers were able to effect a cure of many cases of infection by a variety of bacterial organisms, including the tubercle bacillus. Refinements in the technique included the closure of the wound before beginning instillation of the detergent-antibiotic solution. Antibiotics which were soluble in the solution and also previously determined to be most effective in invitro tests were selected. *Mitra* of Calcutta, India, worked with *Grace* in Brooklyn, and in 1957 (6) they reported complete arrest of 64.21 per cent of 95 cases of chronic pyogenic osteomylitis treated in Calcutta and 69 per cent of 45 similar cases treated at the Grace Clinic, Brooklyn, New York. In these cases the actual surgery performed consisted only of removal of sequestra and other grossly devitalized tissue and opening the medullary canal sufficiently to assure free entry of the detergent-antibiotic solution.

The technique which they recommended in 1958 was as follows:

Mix an antibiotic known to be effective in destroying the bacterial organism with 50 cc's of "Aerosol Wash" solution.[1] The amount of antibiotic mixed with this diluted Aerosol Wash should be the equivalent of the maximum amount which would ordinarily be used in a 24-hour period, orally or intramuscularly, for each 10 cc's of the Wash. Two or more antibiotics have been used simultaneously mixed with the Aerosol Wash. The area from which the drainage is appearing should be opened, definitely necrotic or sequestrated bone removed, a T-tube or urethral catheter inserted, and after thoroughly irrigating the wound it should be closed, leaving the T-tube or catheter in place. Five cc's of the detergent-antibiotic mixture should be instilled through the tube three times each day for five to ten days. Cultures should be obtained from the material withdrawn from the tube by suction with a sterile syringe until at least three consecutive negative cultures have been reported. The tube should then be removed.

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[1] "Aerosol Wash" is a detergent solution prepared by American Cyanamid Company—30 Rockefeller Plaza, New York 20, New York. Aerosol Wash solution consists of: Aerosol-OT 0.68 % W/V di- (2-ethylhexyl) ester of sodium sulfosuccinate. Aerosol-22. 0.08 % W/V N-octadecyl, N (1-2 dicarboxyethyl) tetra-sodium sulfosuccinate, with preservative (hexachlorophene). To 50 cc's of the Aerosol Wash add 50 cc's of distilled water.

The technique described was successfully used by me in the treatment of two cases of post-operative wound infections of the femur and thigh muscles by resistant strains of staphylococcus aureus organisms which had persisted for long periods in spite of maximum doses of antibiotics administered orally and intramuscularly.

Closed continuous circulation of a solution containing antibiotics was first used for patients on the Orthopaedic Service of Chicago Wesley Memorial Hospital. *Goldman, Johnson & Grossberg* (7), resident surgeons in Orthopaedic Surgery, described the technique and reported five cases of osteomyelitis which were cured by continuous or intermittent closed irrigation. The time elapsed between beginning circulation and healing of the wounds was from one to eight weeks. *Dr. Robert T. McElvenny* (8) developed the detail technique described by *Goldman, Johnson & Grossberg.* He reported 12 cases treated by this method.

In each of my small series of cases I have used a 0.1 per cent solution of Aerosol Wash detergent or 0.5 per cent of Alevaire in normal salt solution as solvent for the antibiotic. One gram of Chloromycetin or two grams of novobiocin are added to each liter of solvent. Antibiotics were administered orally or intramuscularly during the period of closed irrigation and continued for varying periods after removing the irrigation tubes. In each of my cases the material sucked from the closed wound has become sterile within four to seven days after starting the closed irrigation. After four consecutive negative cultures the tubes have been removed.

Technique of closed irrigation (circulation) of chronic osteomyelitis and other infected wounds:

1) Sinuses are excised. Sequestra and all necrotic tissues are removed.

2) The multiperforated sections of two non-pyrogenic plastic tubes[1] (1/8 inch diameter) are laid in the wound. Using an 8-inch malleable stainless steel needle, threaded on the blunt end to fit into the tubing, the non-perforated portion of each section of tubing is led out through sound tissue at least one inch from the edge of the wound. Each piece of tubing is anchored to the skin with a single fine suture. (Figure 1).

[1] The tubing and needles are manufactured by the Snyder Manufacturing Company of New Philadelphia, Ohio, and are distributed by the Zimmer Manufacturing Company of Warsaw, Indiana, U. S. A.

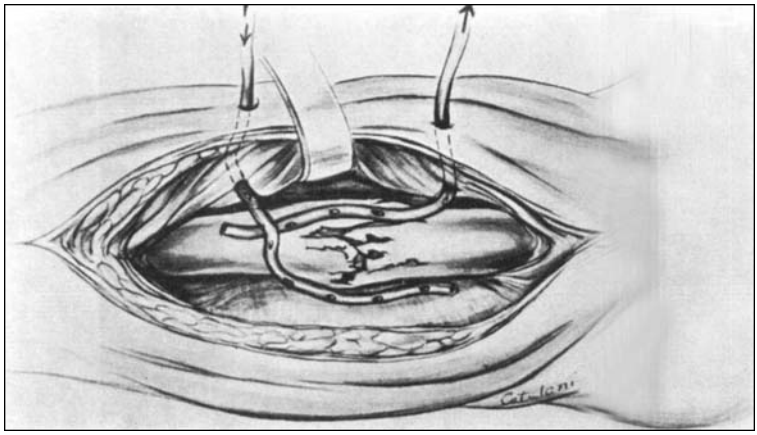

Fig. 1.
This drawing illustrates the way in which the fenestrated tubes are placed in the wound. The detergent-antibiotic solution enters through one tube and is sucked out through the other.

3) The wound is closed tightly with fine stainless steel sutures.

4) The tube for irrigating is attached to an intravenous type of tubing connected with a 1-liter bottle containing the previously prepared detergent-antibiotic solution.

5) The second tube is connected to an electrically driven suction machine such as the Chaffin-Pratt or the Gomco. The negative pressure of the suction machine should not exceed 20 inches of water equivalent.

6) The instillation drip rate should be set to deliver about 80 cc's per hour or approximately two liters during each 24 hours.

In the beginning, continuous suction was maintained, with good results. At the present time intermittent suction is being tried. This permits the wound to fill with the detergent-antibiotic solution. The suction pump is so regulated that every fifteen to twenty minutes it operates just long enough to empty the wound of solution and exudate.

Two of my cases are presented to illustrate the very gratifying results which have been achieved in a small series.

Case 1 F., M. C. W.

This patient, aged 53 years, was first seen and examined by me August 8, 1961, because of an infected fracture of the neck of the left femur. The fracture had occured December 12, 1960. A Smith-Petersen nail, with a femoral plate, was used

Fig. 2.

Case 1. This roentgenogram shows extensive destruction of the hip, including the head and neck of the femur. Negative cultures were obtained after less than one week of closed irrigation.

December 13, 1960, for immobilization of the fracture. Twelve days later drainage from the incision began. She was treated with Kantrex, other antibiotics and vitamins, but the drainage continued.

My examination showed purulent drainage from a sinus tract near the upper end of the left subtrochanteric operative scar. There was also induration all along the upper portion of the scar, but the distal portion of the incision was healed. X-rays showed union of the fracture, but definite evidence of necrosis of the head of the femur.

The patient was admitted to the Chicago Wesley Memorial Hospital August 12, 1961, and August 14, 1961, the plate and nail were removed. There was definite purulent material surrounding the nail and plate. This was thoroughly irrigated with warm isotonic sodium chloride solution. The wound was then closed, after inserting irrigation tubes. The lower tube was attached to an electric suction pump; the upper tube was attached to a 1-liter intravenous flask containing normal salt solution, two grams of novobiocin and five cc's of Alevaire. One gram of Albamycin was given by mouth each day. Two liters of the solution containing antibiotic and the Alevaire detergent were used each 24 hours. There was a continuous slow drip which usually emptied the one-liter flask in about 12 hours and then this was changed. Gradually the drainage or suction of material from the wound became more clear and free from debris, and after one week, negative cultures were obtained. After four negative cultures on consecutive days, the suction and irrigation tubes were removed. The wound healed completely and the patient was discharged.

October 23, 1961, about nine weeks after the operation and institution of continuous irrigation and drainage, there was a flareup with redness and swelling. This subsided with antibiotics taken by mouth, but the inflammation recurred and

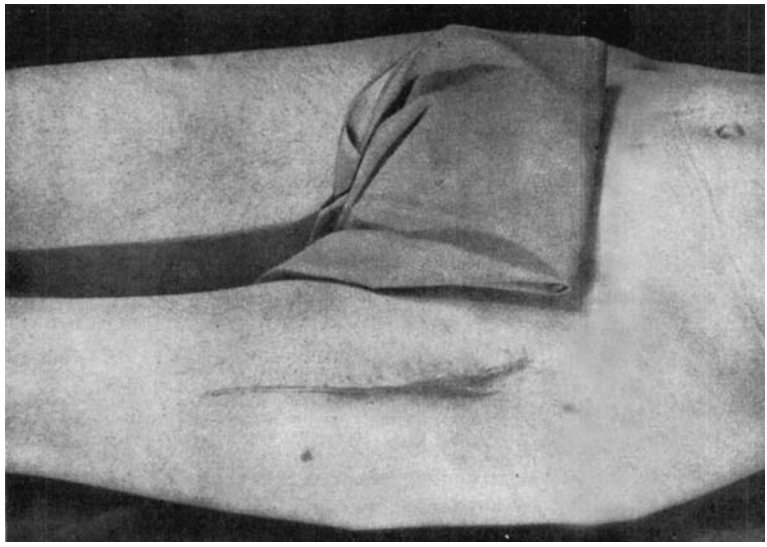

Fig. 3.

Case 1. This photograph shows the scar of the healed wound. The two dark spots lateral to the linear scar are the sites where the irrigation tubes were brought out through the skin.

December 2, 1961, more than four months after operation, the incision was opened and a large abscess was evacuated. This continued to drain until February, 1962, when the patient was readmitted to the hospital, and on February 20, 1962, the sinus tract was dissected out; the hip joint was opened widely. This time, there was extensive purulent material within the joint and partial destruction of the head of the femur. (Figure 2). Closed irrigation was again instituted. Within four days the patient was afebrile. Irrigation was continued with the novobiocin and Alevaire solution as described above. After one week, cultures became negative and after five consecutive negative cultures the irrigation tubes were removed and the patient was discharged March 7, 1962, with the wound completely healed. (Figure 3).

Case 2. Male, aged 56 years, R. V. P.

In April 1961, this fifty-six year old surgeon began to suffer from pain in his left tibia about three inches below the knee. A roentgenogram revealed a destructive lesion in the tibia which consulting physicians thought was probably a malignancy. On operation, however, it was found to be an abscess with thick, purulent material and from this was cultured a hemolytic staphylococcus aureus, varidase and coagulase positive. This proved to be a very resistant organism. Hematogenous osteomyelitis in an adult is rare. Such infections in this era of antibiotics in a patient 56 years of age are exceedingly uncommon.

September 24, 1961, while this patient was swimming in the ocean, although he still had a draining sinus, a large log which was partially submerged was brought

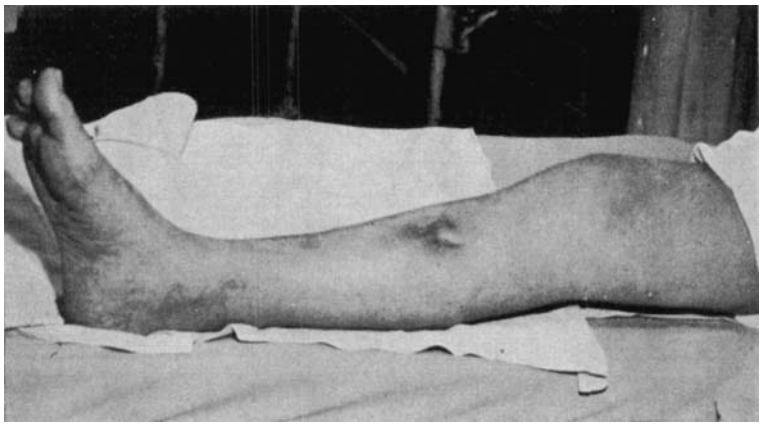

Fig. 4.

Case 2. Completely healed hematogenous osteomyelitis of the tibia. Purulent drainage had been continuously present for eight months. Sterile cultures were obtained after four days of closed irrigation with the detergent-antibiotic solution.

in on a wave and struck the left tibia. This caused a fracture of the tibia through the site of infection. October 23, 1961, the osteimyelitis area was re-explored by Dr. *Paul McMaster* of Beverly Hills, California, and a large sequestrum, involving almost the full diameter of the tibia, was removed. This left a defect of approximately 1–½ inches, which was still present when I first examined him November 18, 1961. I advised operation to clean out the necrotic tissue and start continuous irrigation with detergent and antibiotic material.

December 1, 1961, I carried out the operation in a manner described in a preceding part of this report. Before excising the sinus and opening the abscess area in the tibia, I did an osteotomy in the lower third of the left fibula and then sealed off this incision. In addition to the sinus, there developed in the few weeks after my first examination of this patient, and before his arrival in Chicago for the operation, a bluish area of necrosis of the skin and subcutaneous tissue about 1 inch medial to the draining sinus. This was an unexpected complication, but I proceeded to carry out the operation as planned. The suction and irrigation tubes were placed in the wound and the incision closed. He was given Albamycin, mgms. 250, four times each day by mouth. Continuous irrigation was maintained using the slow drip method. To each liter of isotonic sodium chloride solution was added 5 cc's of Alevaire and 2 grams of novobiocin. Two liters were used each 24 hours. Once each day the suction tube was disconnected from the Chaffin-Pratt electrically driven suction machine, a sterile syringe was attached to this tube and strong suction applied. During each of the first three or four days, 20 to 30 cubic centimeters of exudate and necrotic material were withdrawn into the syringe. This was cultured and the tube connected to the electrically operated suction machine. On the fourth day after starting the continuous irrigation, the material obtained from the suction tube proved to be sterile and continued to be sterile each day thereafter. December 10, 1961, nine days after the operation and the institution of continuous irrigation, the

Fig. 5.

Case 2. This roentgenogram shows evidence of healing of the fracture which had occurred through the osteomyelitis focus.

plaster cast was removed; the dressings, which were soaked with exudate as well as with the irrigation solution, were all removed. The 1-½ to 2 cm. area which had been observed to be bluish discolored and apparently becoming necrotic had completely broken down. This necrotic tissue was removed, leaving a deep defect. The hemovac irrigation and drainage tubes were removed, and the defect left when the necrotic tissue had been removed was loosely packed with vaseline gauze. A light compression dressing was applied from the foot to above the knee and a posterior plaster mold was bandaged firmly to the leg.

December 21, 1961, twenty days after the operation, the dressings were all removed, the wound appeared to be clean and the incision had healed. The defect adjacent to the incision from which the necrotic tissue had been removed was healing. A new cast was applied and a walking heel attached to it. The patient was advised to begin partial weightbearing and December 22, 1961, he returned to California. A telephone call January 30, 1962, stated that he was having no pain and could bear full weight without any difficulty. The cast which had been applied in Chicago, December 21, 1961, removed in California about February 15, 1962. The wound was found to be

completely healed, and the defect created by the removal of the necrotic tissue had also healed. A new cast was applied.

The patient returned to Chicago and was admitted to the Chicago Wesley Memorial Hospital, March 12, 1962. When I removed the cast I found slight redness and swelling in the area in which the necrosis had been present. He was last examined by me April 24, 1962. The wound was completely healed and clean, there was clinical evidence of fibrous union of the fracture of the tibia. A new cast was applied. He has been walking with full weightbearing without cane or crutches.

Figure 4 is a photograph of the completely healed wound. Figure 5 is a roentgenogram of the tibia showing callus formation at the site of the infected fracture.

SUMMARY

Continous closed circulation of infected wounds and chronic osteomyelitis with a solution containing a detergent and one or more antibiotics has been successful in eliminating the infection and obtaining healing. In the preliminary reports of the cases treated by this method, the results appear to be even more spectacular than those reported by Grace and Mitra in which they instilled antibiotics in a detergent solvent solution. My experience with and observation of a small series of cases treated by each of the three methods encourages me to continue to use the combination of a detergent and antibiotics in a solution of isotonic sodium chloride for closed circulation (irrigation) of cases of chronic osteomyelitis and orthopaedic wound infections. This study is still in a very preliminary phase. After three or four more years I shall hope to be able to report a significant series of end-results.

RESUME

Dans les cas de plaies infectées et d'ostéomyélites chroniques, une circulation continue close d'une solution contenant un détersif et un ou plusieurs antibiotiques a été appliquée avec succès; l'infection a été éliminée et la guérison obtenue. Dans le rapport préliminaire des cas traités par cette méthode, les résultats paraissent encore plus spectaculaires que ceux rapportés par Grace et Mitra dans lesquels il avait instillé des antibiotiques dans une solution d'un solvant détersif. L'expérience que j'ai retirée de l'observation d'une petite série de cas traités par chacune des trois méthodes m'encourage à utiliser la combinaison d'un détersif et d'antibiotiques dans une solution de chlorure de sodium isotonique en circulation close (irrigation) dans les cas d'ostéomyélites chroniques ou de plaies orthopédiques infectées. Cette étude en est toujours à une phase préparatoire. Au bout de trois ou quatre ans j'espére pouvoir rapporter une série importante de résultats finaux.

ZUSAMMENFASSUNG

Fortlaufende, geschlossene Spülung von infizierten Wunden und chronischer Osteomyelitis mit einer Lösung, die ein Detergens und ein oder mehrere Antibiotica enthält, wurde mit Erfolg zur Uberwindung der Infektion und zur Erreichung der Heilung angewendet. In den vorläufigen Berichten über die Fälle, die in dieser Weise behandelt wurden, erscheinen die Ergebnisse noch aufsichtsweckender als jene, die von Grace und Mitra berichtet worden sind und in denen sie Antibiotica, gelöst in einer Detergenslösung, instillierten. Meine Erfahrung und Beobachtung in einer kleinen Reihe von Fällen, die mit jeder der drei Methoden behandelt wurden, ermutigt mich die Kombination eines Detergens und Antibiotica in einer physiologischen Kochsalzlösung für die geschlossene Spülung (Irrigation) in Fällen von chronischer Osteomylitis und orthopedischen Wundinfektionen fortgesetzt zu verwenden. Diese Studie befindet sich noch in einem äusserst vorläufigen Stadium. Nach weiteren drei oder vier Jahren hoffe ich in der Lage zu sein eine gewichtigere Reihe von Endergebnissen vorzulegen.

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