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## DENTAL OBSERVATIONS MADE WHILE WINTERING IN ANTARCTICA, 1956-1957

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**E**ARLY in the initial planning of the United States National Committee for the International Geophysical Year, the Dental Division of the Bureau of Medicine and Surgery began to explore the possibilities of including a dental officer in the wintering-over party of the operation known as Deepfreeze I. The assignment of a dentist to the already formed group of 92 men was accomplished in September, 1955. Primarily, the dentist's duties were to include the emergency and routine treatment of these 92 men, but because of the unusual nature of the operation, where men would be subjected to the isolation and the physical and psychological stresses of life on a continent having a prolonged night and temperatures far below those experienced anywhere else in the world, it was hoped that some insight might be obtained on the effect of these conditions on oral health.

The course decided upon was one of clinical observation in which the dental officer would observe and report any clinical conditions that might be worthy of future investigation. Also, it was hoped that some insight might be gained in cariogenic trends determined through clinical, radiographic, and bacteriologic studies. Observations of soft tissue changes, as well as dietary desires, smoking habits, and oral hygiene procedures, were placed in the experimental outline.<sup>1</sup>

A landing was made at McMurdo Sound, Antarctica, the latter part of January, 1956, and, because of the activities associated with survival, it soon became apparent that definitive laboratory investigations would have to be deferred until the operation's pioneer first-year phase had passed.

### REVIEW OF THE LITERATURE

References to the health and well-being of men participating in previous Antarctic expeditions are numerous. Included in these reports are frequent observations of oral health in which dental complaints play an outstanding part. According to Frazier, a physician at Little America with Admiral Byrd during the 1939-41 expedition: "Most of our problems, medically, were teeth."<sup>2</sup> Mountevans<sup>3</sup> repeatedly pointed out that in the traverse teams of almost every Antarctic expedition many men suffered from bleeding, sore, swollen gingiva and looseness of the teeth, which, in hindsight, he attributed to an improper diet lacking particularly in vitamin C.

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Cherry-Garrard,<sup>4</sup> on Scott's last expedition, wrote that an almost unbelievable dental condition occurred: "In the pauses of our marching we halted in our harnesses, the ropes of which lay slack in the powdery snow. We stood panting with our backs against the mountainous mass of frozen gear which was our load. There was no wind, at any rate no more than light airs: our breath crackled as it froze. There was no unnecessary conversation: I don't know why our tongues never got frozen, but all my teeth, the nerves of which had been killed, split to pieces."

Amundsen<sup>5</sup> wrote of the need for adequate dental first aid equipment. Giaever<sup>6</sup> remarked on the deplorable state of oral hygiene noticed in his personnel, stating that "the toothbrush remains for most rather an instrument for use on ceremonial occasions." Frazier wrote<sup>2</sup>: "All devitalized and carious teeth became painful and had to be extracted. As soon as cold air was brought in contact with these diseased teeth, the pain became unbearable. As the cold increased with the coming of winter, the alloy fillings contracted and pulled away from the cavities they were protecting. Some fell out immediately and others began to leak resulting in decay under fillings. Many good teeth were lost in this manner. Front teeth with large fillings and gold inlays became very painful on exposure to low temperatures. The back molars, protected by the tongue and cheek, were the least affected." Frazier further stated that wintering parties have higher than usual epinephrine levels. He cited a number of cases in which varying degrees of shock were elicited through the administration of Novocain solution containing varying concentrations of Adrenalin, ranging from 8 minims to 2 minims per ounce of anesthetic solution. He finally reached a point where Adrenalin-free anesthetic solutions were used.

OBSERVATIONS ON ORAL HEALTH, 1956-57, AT MC MURDO SOUND, ANTARCTICA

*Patient Load.*—

Ninety-three men were stationed at McMurdo Sound, Antarctica, during the winter, 1956. Since one of these was a dentist, 92 men were eligible for dental treatment. At no time did the dentist solicit patients but 89 men voluntarily sought aid. Table I shows the month-by-month demand for dental and medical service expressed in numbers and per cent of total population. Each patient is counted but once a month regardless of the frequency of his visits or multiplicity of his complaints.

TABLE I

MONTH	PER CENT OF		PER CENT OF	
	NO. OF MEN UNDER DENTAL TREATMENT	TOTAL POPULATION UNDER DENTAL TREATMENT	NO. OF MEN UNDER MEDICAL TREATMENT	TOTAL POPULATION UNDER MEDICAL TREATMENT
April	35	38.0	40	43.5
May	39	42.4	34	37.0
June	27	29.3	30	32.6
July	32	34.8	47	51.1
August	39	42.4	54	58.7
September	47	51.5	52	56.5

The months April through September were chosen for their statistical significance for at least 3 reasons. It was during this period that the camp population remained static; there were no transient personnel. These were the months of the severe Antarctic winter, with temperatures frequently below the  $-50^{\circ}$  F. mark. It was necessary for men to spend as much as 12 hours a day, 7 days a week, in preparation for the returning scientific personnel who would gather their data during the International Geophysical Year.

The number of patients seeking treatment in April and May, though relatively high, increased only slightly in May over April. In June, the men remained indoors and one would have predicted on the basis of time available for treatment, that the number of persons desiring routine treatment would have increased but there was a 13.1 per cent drop in demand. As the winter night progressed and the men returned outdoors in mid-July, the incidence of persons seeking dental aid increased each month until September when more than half of the camp personnel were under treatment.

A comparison of the demand for medical and dental treatment is interesting (Table I). Whereas the demand for dental treatment increased in May over April, the demand for medical care decreased. In June there was a greater decrease in demand for dental care than for medical care. In July, upon returning outdoors, there was a sharp increase in the need for medical services amounting to 18 per cent, increasing still higher by 7.6 per cent in August, and then apparently leveling off in September. Many of these patients sought aid for traumatic injuries while working in low temperatures during the Antarctic night.

*Dental Treatment.*—

The call for dental services can be broadly grouped into 3 categories: (1) teeth, (2) supporting structures, and (3) prosthetic appliances.

Much has been written by persons not trained in dental observations concerning the loss of fillings from teeth through the differences of coefficient of contraction of tooth substance and filling material when exposed to the severe cold of the South Polar continent. It seems highly improbable that this is so, since air, cold enough to cause metallic contraction of such magnitude as to bring about loss of the filling, would certainly have effects on other tissues. Armstrong and Huber<sup>7</sup> and others have found no measurable filling change or dislodgment when teeth were subjected to severe rapid changes in temperature. Certainly, if a vital tooth was involved, such a thermal change would cause a severe toothache. Again, if these thermal extremes were reached, we could expect some effect on the oral mucous membrane and the pulmonary tissues. Teeth were the only oral tissues reported to have been affected by the cold.

Restorations did fall out; in one day alone, there were 4 cases. In almost every instance their loss could be explained by the presence of secondary decay, occlusal trauma, or some other physical reason.

In this first expedition, time was not available before departure to check thoroughly and correct the dental deficiencies existing in the men. It is entirely

possible that, had these men had adequate treatment prior to leaving, results paralleling those of Admiral Byrd's 1928 Antarctic expedition would have been achieved. Prior to this expedition, Nelson<sup>8</sup> made every man "dentally fit." "Every cavity was filled with the best obtainable material and the gums given the best possible treatment. Every dental fault was corrected." Upon return of the expedition in 1930, Nelson re-examined<sup>9</sup> 59 of the group who had been in Antarctica for a 2-year period and reported that there were some new cavities which had developed. Of the 59 men examined, 28 had no new cavities or restorative work necessary. There were 42 new cavities in the remaining 31 men, 2 broken teeth, and 4 broken fillings. These broken restorations had been placed some time prior to 1928. These men were under professional observation and loss of restorations due to extreme temperatures was not a cold-weather dental problem. All the personnel of the Antarctic expeditions during the International Geophysical Year through 1959 will be closely observed, however, and it is hoped that a final answer to this problem will be had from the collected data.

*Tooth splitting or fracture:* The phenomenon of tooth splitting in cold weather, which was reported by Cherry-Garrard,<sup>4</sup> was not observed at any time in the personnel of Deepfreeze I. Since pre-expedition radiographs were not available, it cannot definitely be stated that any pulpless teeth of long duration existed in this group of men. Several teeth were pulp treated and the root canals filled during the expedition but these did not prove to be a problem.

In other instances, tooth cusps fractured or other forms of tooth substance were lost but, once again, professional analysis at the time attributed the splitting to secondary decay, undermined enamel, or entirely to the trauma of occlusion.

*Cold and toothache:* Toothache due to inhalation of cold air was a rather common complaint. In the majority of instances it occurred in teeth with metal restorations in which insulating bases were inadequate or missing. With most of these there was no previous history of odontalgia and the placement of the restorations in the involved teeth dated from 6 years to a few months prior to departure on the expedition. The histories of these patients were all quite similar. They had had no dental troubles until they went outdoors in low temperatures. The toothache was moderately severe and of durations ranging from a few hours to a few days. Many of these men attempted self-treatment by taking aspirin and, in many instances, this medication offered temporary relief from pain. The severity of the pain could not be correlated with the size of the metallic restorations because in several instances a clinically small insignificant-looking occlusal amalgam was the offender. In each case, however, these were quite deep and without insulation.

Treatment for toothaches with cold as the etiologic agent consisted of removal of the metallic restoration and replacement of it with zinc oxide and eugenol for a few days until the pulpal hyperemia disappeared. This zinc oxide and eugenol was then replaced with an amalgam and an oxyphosphate cement

base. In several instances where the cavity was particularly deep, a small amount of the sedative base was allowed to remain and the oxyphosphate base was used as an intermediate base. In every instance where pulpal deterioration had not taken place, this treatment proved successful and the tooth remained comfortable for the remainder of the stay in Antarctica.

Teeth with large unfilled cavities were not too great a problem insofar as their reaction to cold temperatures was concerned. Many patients sought routine dental treatment because of its availability at which time the dentist discovered large and sometimes very deep cavities. Upon questioning the patient about his experiences in the cold air, the answer was usually that cold air had no effect on them. From this, the only conclusion that can be drawn is that the decalcified material and food debris packed in the cavity acted as an insulating layer and that pain occurred only through the prolonged chilling of the un-insulated metallic restorations.

Another common complaint of the teeth associated with cold temperatures is pain due to the exposure of the necks of teeth. There did not seem to be any correlation between this condition and the rather common complaint of hypersensitive cervical dentin. Relief from the latter was usually realized upon the application of silver nitrate.

When restorations are placed in accordance with accepted standards, cold air as an etiological factor in odontalgia, or cold air as an etiological factor in loss of restorations, is negligible. If the carious process has progressed to any extent, an intermediate base of zinc-phosphate cement or a combination of zinc oxide-eugenol and zinc-phosphate cement should be used. The rule followed was that if there was any doubt, a cement base was used. The pleasing result was that virtually every tooth filled was comfortable from the first day and remained so for the entire stay.

#### *Supporting Tissues.*—

*Alveolar osteitis* ("dry socket"): During this first year in Antarctica, 44 extractions were performed. All extractions were performed under local anesthesia with instruments boiled for at least 15 minutes immediately prior to the operation and transferred from the boiling water to an autoclaved towel by means of sterile forceps. The operator's hands were scrubbed with soap and water.

Of the teeth extracted, 11 were abscessed, 16 had carious exposures, and 17 were removed electively, usually third molars having no antagonist or having had a history of being the etiological factor in a pericoronitis. Of the 44 extractions, only one could be considered difficult. Of those teeth removed in the presence of infection, antibiotics were administered at the discretion of the dentist. Immediate postoperative treatment consisted of ascertaining that an adequate blood clot had formed and giving the patient instructions about not disturbing the clot with the tongue, food, or forceful mouth rinses. The exposure of the patient to the severe cold and wind of the outdoors during the times it was necessary to walk from his quarters to other base activities for eating, working, recreation, or returning to the dental office, was unavoidable.



Alveolar osteitis followed 10 of the 44 extractions, an average of 22.73 per cent as compared with 0.9 per cent average as reported by The University of Pittsburgh School of Dentistry<sup>10</sup> in a study of 23,886 cases following extraction. This condition appeared both as an infected socket with a deteriorating blood clot or as a dry socket with the complete loss of the clot. The ensuing number of treatments required in a given case ranged from 1 to 19.

The etiological factor or factors were not sought during this first expedition because of the lack of facilities to carry out such an investigation. Various theories have been advanced and will be studied in future expeditions. These theories include as the etiological factor of alveolar osteitis in Antarctica: (1) viral or bacterial infection, (2) disturbances in the bleeding and clotting times as determined by the fibrinogen, thrombin-prothrombin, calcium and platelet blood levels, (3) the effect of cold itself on the clotting mechanism, (4) a general lowering of tissue resistance due to the stresses of Antarctic life, and (5) the vasoconstrictive action of epinephrine in the presence of high epinephrine blood levels.

*Periodontal disorders:* During this expedition there was only a small number of periodontal disorders to be treated by the dental officer. Gingival disorders usually responded to routine treatment once the etiology was ascertained. There were several cases of pericoronitis and these, too, responded favorably to treatment. In several instances of recurring pericoronitis the third molar was eventually removed.

Aphthous stomatitis appeared in about 10 per cent of the personnel. Treatment in each instance consisted of a mild astringent applied to the lesion as early as possible. No further treatment was considered necessary and complete healing was usually effected in 7 to 10 days.

Two cases of general soft tissue inflammatory condition appeared at a time after several weeks of extended work before the period of darkness arrived. The personnel had been working 12 hour shifts, 7 days a week, and there was a noticeable weariness in the men. The men had been told a few days previously that there still remained much necessary outdoor work. In one instance, a patient presented with an annoying aphthous lesion on the mucous membrane of the lower lip, and very sore and bleeding gingiva. The aphthous stomatitis was treated with a mild astringent and the patient asked to return the following morning for a scaling to treat the inflamed gingiva. Examination the next morning revealed a mouth with normally colored gingival mucous membranes. The swelling had disappeared, the soreness was gone and the gingival tissues did not bleed on pressure. The patient also stated that, physically, he felt better. A further history revealed that the patient had been under considerable tension and fatigue for several days in this prolonged outdoor work. His mouth during this time had become progressively more uncomfortable and the night before he had originally reported to the dental office he had had only 4 hours of sleep. Since appearing the day before he had a long sleep and a warm shower—the only treatment. His teeth were subsequently scaled and no further treatment was necessary.

*Oral hygiene:* Some previous Antarctic expeditions have reported deplorable oral hygiene practices.<sup>6</sup> It is presumed that this condition could exist because of the lack of basic training in the importance of a clean mouth or because of inadequate facilities to make toothbrushing possible. In all previous expeditions, camp facilities were primitive and exploratory traverses were either on foot or with dog team and lasted for weeks and even months. Toothbrushing under these conditions was almost an impossibility.

The life of our Antarctic explorers today can be compared with their predecessors in only limited areas. Traverses that took months now take hours with the airplane. Primitive camp facilities have been replaced with recreation rooms and running warm water for showers.

Mouth hygiene of Deepfreeze I personnel was generally good. The presence of excellent camp leadership was reflected in the cleanliness of the camp, and the presence of a physician and dentist was reflected in good personal and oral hygiene.

*Dental calculus:* Nelson examined the returning members of Admiral Byrd's expedition and reported that there was not a single case of excessive calculus deposit.<sup>9</sup> In observation of Deepfreeze I personnel, the deposition of calculus appears to progress at about the same rate as it would in the United States. Those persons who previously had histories of heavy deposits continued to have heavy deposits requiring frequent scalings and those persons with little tendency to calcific deposits continued to show the same trends.

#### *Prosthetic Appliances.—*

From January, 1956, to January, 1957, it was necessary to repair 8 dentures. A ninth case was seen in consultation with the dental officer attached to an ice breaker. Of these cases only 1 could be definitely attributed to the cold weather. In this instance, a man wearing a full upper denture had been standing a 4-hour watch on a cold windy day. He was a mouth breather and, during this watch, he stated he could actually feel the denture cracking as he breathed through his mouth. Subsequent examination of the denture revealed a great number of small cracks. The denture had been worn about 5 to 6 months prior to this peculiar fracturing.

Of the remaining dentures seen for repair, 5 had been broken as the result of direct trauma. The remaining 3 fractured during eating and may or may not have been the result of rapid temperature change from outdoors to the warmth of food. However, these 3 dentures were fractured in a single line and exhibited none of the "shattering" effect seen in the full denture.

#### *Miscellaneous.—*

*Shock following local anesthesia:* Frazier reported that "adrenalin shock"<sup>2</sup> frequently followed injection of a local anesthesia containing Adrenalin into camp personnel who were cold acclimatized. He theorized that this resulted from an increase in the already high epinephrine blood levels. A series of experiments were carried out by him with varying concentrations and over extended periods, and he was able to reproduce this condition at will.



On the basis of this report, the use of local anesthetics and patient reaction were carefully observed. In the use of 250 cartridges of 2 per cent lidocaine hydrochloride, containing 1:50,000 epinephrine, only 2 cases of syncope were observed. Both patients appeared at morning appointments and had had no breakfast prior to the visit to the dentist. Both patients were given the same type of anesthetic at subsequent sittings and experienced no untoward results.

*Focus of infection:* During the stay at the McMurdo Sound wintering camp, the study of 1 patient strongly suggested to the dental officer and medical officer that this patient's traumatic arthritis had been kept active through the influence of a dental focus of infection.

#### CONCLUSIONS AND SUMMARY

The presence of a dentist in an expedition to Antarctica is a necessary factor in raising the morale and tending to the dental complaints of the expedition's personnel. His importance is shown by the fact that 89 persons out of 92 sought his aid during this year's stay in Antarctica.

Odontalgia as a result of thermal conductivity through metallic restorations lacking or insufficient in intermediate cement bases is a common Antarctic dental complaint. This condition can be controlled by replacing the restoration and supplying the tooth with an adequate insulating cement base.

Hypersensitive cervical dentin was also a common complaint, controlled through the use of silver nitrate, or, if such conservative measure failed, a cavity was prepared and an insulated filling was placed. It is the firm belief of the observer that restorations placed under standard methods were easily tolerated and remained intact.

Loss of restorations through the action of the Antarctic cold did not prove to be a problem as previously reported. No marginal leakage was observed through contraction and each restoration, that did fall out, fell out because of some pre-existing condition such as secondary decay, undermined enamel, or trauma.

Observations of the soft tissues and periodontal structures indicated that, given the facilities and time, oral hygiene remained good. Generalized periodontal trouble was not a problem but 2 cases were cited where the etiology appeared to be long hours of exhaustive work at low temperatures. Several cases of aphthous stomatitis appeared and were treated with a mild astringent. These aphthae healed in the normal time of 7 to 10 days. The rate of deposition of dental calculus did not appear to be unusual or to change from what would be expected in the same individual if living elsewhere.

Alveolar osteitis was a problem and occurred once after every 4 or 5 extractions. All extractions were done under generally accepted procedures of sterility and it is the authors' belief, in retrospect, that the exposure of the patient to the severe cold at times during the healing process may have been the inciting cause for this condition.

Adrenalin shock following the injection of a local anesthetic containing epinephrine was never a problem as reported in previous expeditions. Two

cases of syncope occurred in the 250 anesthetic administrations but these could not be correlated with the increased blood epinephrine levels and were not reproduced in subsequent visits.

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