Analysis of dental care in Antarctic crews: Dental problems, case studies and treatments

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Abstract

Dental issues are relatively common in Antarctic stations both during short-term and long-term expeditions. In overwintering crews, dental problems may reach 10-15% of overall medical cases. In the expeditions working only during the austral summer season, the proportion of dental problems is lower, typically not exceeding 5%. In our study, facilities available recently for dental care in Antarctica, considering seasonal – and year-round operated stations, are overviewed. Several case studies are reported in order to show the treatment of the most frequent dental problems that happen in Antarctica in short-term (seasonal) and long-term (overwintering) expeditions. Our study brings an analysis of dental cases reported by Czech Antarctic Program within 15 years (2008-2015) and the Brazilian Antarctic Program (2018-2023). New trends in dental care in Antarctica are discussed including telemedicine and integrated systems.

Key words: Antarctic expeditions, dentistry, dental treatment, Mendel station

DOI: 10.5817/CPR2023-2-13

Received May 30, 2023, *accepted* November 17, 2023.
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Acknowledgements: The authors thank national Antarctic programmes (CARP, PROANTAR) that provided data as well as the Czech Antarctic Infrastructure (CARI). The authors are also grateful to the profesionals in medical care within particular international Antarctic programmes and volunteers who participated in this study by filling questionaire.

Introduction

History of dental care in the heroic age of Antarctic expeditions

Dental problems on the expeditions were, and still are, common in Antarctic expeditions. The first mentions relate to the race to the South Pole, *i.e.* Amundsen and Scott´s expeditions (1910-1913). Guly (2011, 2015) studied the reports from Shackleton's ship Endurance stuck in the Antarctic (1915) and Scott's expedition. The author is not aware of any description of dental problems during the Heroic Age (British expeditions). However, loosening of the teeth due to scorbutic periodontitis is reported for members of Scott's expedition by Ellis (1969). Guly (2015), moreover, refers to the use of anesthesia in Dr. Archibald McLean's description of his own dental extraction during the Australasian expedition (AAE, 1911-1914): "Had hard luck this afternoon. Decided to have a tooth out. 'Doc' [Dr Leslie] Whetter injected 'codrenine' [a combination of cocaine and adrenaline] but the tooth broke and turned out to be the wrong one. So had a whiff of chloroform and the other tooth out." (in Mawson 1915).

Dental issues in Antarctica, from history to recent times

An overview of dental care in Antarctica was done by Lisney (1976) who reported generally poor oral hygiene in expedition staff before the International Polar Year (IGY, 1957-1958). The main dental problems recorded in the period before the IGY were related to toothache caused by inadequately lined restorations or exposed dentine or cementum in the cervical areas of the teeth (Knoedler and Stanmeyer 1958). Within the IGY and shortly after, several countries (*e.g.* US – Stanmeyer and Adams 1961, Great Britain – Pidgeon 1960), sent dental teams to Antarctica in order to treat dental problems of the crews and analyze the causes of dental problems. In this period, several important findings were made. Among them, the finding that dental fillings fell out due to recurrent caries but not because of cold-induced contraction of dental filling material.

Overview of recent dental care in Antarctica

To carry out medical care, research, and investigations is essential in Antarctica, both in overwintering and short-term crews. Long-term medical data (50 years; Ikeda et al. 2019, Kuwabara et al. 2021) showed that the majority of diseases belong to 1) surgery and orthopedics, 2) internal problems, and 3) dentistry. In the study, dental problems were the third most frequent, reaching 12% of cases. Therefore, comprehensive information and database on dental care in Antarctica is needed so that proper dental care can be provided during expeditions. Risks of dental problems in Antarctica are similar to those in high mountains (Küpper et al. 2014), however, long-term stays of crews in Antarctica bring higher probability and frequency of dental problems. Classification of dental problems is sometimes problematic in Antarctica because of missing information due to insufficient examination protocol. However, Zaitsu and Kawaguchi (2017) have identified six major dental problems, such as 1) Abscess, 2) Avulsion/Tooth Loss, 3) Caries, 4) Crown Replacement,

5) Exposed Pulp/Pulpitis, and 6) Filling Replacement.

In Antarctica, weather conditions and human activities create an environment in which the use of analgesics and antiinflammatories is commonplace. For example, injuries are frequently reported, however, other issues such as dental problems or disturbances of the gastrointestinal tract are also described (Bhatia and Pal 2012, Ohno et al. 2018), together with a restricted provision of professional health care (Olson 2002). Therefore, in the Antarctic overwintering crew, the most common cases comprise injuries, followed by internal medicine issues and dental problems (Cadden 2017). In general, overwintering is associated with significant changes in sleep patterns and a higher susceptibility to psycho-social stress. Moreover, total darkness, extreme-low temperature, strong wind, and slippery road condition brings an increased risk of physical injuries including those in the orofacial region. Dental problems are known to be prevalent at every Antarctic station hosting overwintering crews. Based on long-term data reported by Ohno et al. (2018) for the Japanese station Sayowa, dental problems may form up to 13.0%. Similar share of 11.9% is reported as averaged value for 7 consecutive Ukranian expeditions at Vernadsky station (Moiseyenko et al. 2016). In a single expedition trip, however, the dental issues share may be low (2%), as reported *e.g.* by Bhatia and Pal (2012) for the Indian Antarctic expedition (Maitri station), Mill and Mills (2008). Retrospective analysis of dental morbidity between 2015–2020 is reported by McColl et al. (2022).

Most common dental problems

Dental problems present a potential burden to the expeditions to remote locations and wildness (Mellor et al. 2015). According to Langdana (2014), the most common dental issues on expeditions are the following (listed by seriousness): (1) Caries and Infection, (2) Pulpitis/Apical Abscess, (3) Abscesses, (4) Gingivitis, and (5) Pericoronitis. Lloro et al. (2019) analyzed dental events in Antarctic missions. The study took into account 70 cases and showed a higher dental incidence rate in Antarctica compared to non-isolated conditions. Major cases were caries and secondary decay events followed by fractures of teeth or tooth problems not due to tooth decay. The study stated that third molar and endodontic problems were not observed in Antarctic expedition in spite of the fact they were reported from other types of isolated missions such as *e.g.* maneuvers and submarine cruises. The study was made in order to suggest future dental prevention strategies in isolated missions since dental care during expeditions and similar outdoor activities has been increasingly important within the last few decades (Langdana 2020).

Our study follows up on the preliminary report on dental care provided during Czech Antarctic expedition (Bartáková 2020). It aims to evaluate dental cases, disease and injury trends among the members of Czech (1 or 2 month-long) and Brazilian (long-term) expeditions with special respect to dental problems and their treatment. A comparison of dental problems reported from short and long-term (overwintering) expeditions is made. Finally, recent trends and perspectives for future dental care in Antarctica are reported and analyzed.

Material and Methods

The research was done to evaluate the dental-related issues by the two following approaches: (1) interviews with the participants of Czech Antarctic expeditions and medical doctors serving during the expeditions in order to provide medical care and emergency medicine, if needed, and (2) sending a questionnaire to medical doctors who worked in Antarctic stations during overwintering expeditions.

The above-specified groups of people were chosen because of the fact that feedback provided to them resulted in dental case reports and provided basic data for the evaluation of recent dental care in Antarctic crews. The interviews and questionnaire focused on the following aspects of dental issues: dental check-up before expedition (Yes/No), X-ray scan of the dental arch before expedition (Yes/No), the character of dental treatment before expedition (if there was any), problems in orofacial region during expedition reported by crew members (Yes/No), any dental care-related activity, dental problem description, dental treatment at the station. Medical doctors were asked to describe dental cases and their treatments. Information regarding dental care in Antarctica during the expeditions was summarized and reported in summary tables. The questionnaire for medical doctors focused also on several professional aspects related to dentistry. Among them, questions related to pre-deployment training in the field of dental care were asked. Data on dental care provided during Czech and Brazilian Antarctic programs were analyzed in order to point out the most frequent cases and typical treatment.

Results and Discussion

Pre-expedition dental care of Czech expedition members

The majority of Czech Antarctic crew members passed a comprehensive examination of the oral cavity, typically at a dental clinic. The examination included an intraoral X-ray (Bite Wings X-ray left and right, and the orthopantomogram X-ray) and identification of caries including their morphology and the degree of development. Within the period of interest, the caries were found in the incisors in the upper jaw (2 cases), molars in the lower (2 cases), and upper jaw (1 case). The caries were drilled out, and, consequently, dental treatment was applied by filling the cavity with a dental composite. In two cases, the molars (both No. 8 in the upper and lower jaw) were extracted. Before the extraction, local anesthesia was applied. Then, the extraction with removal of the necessary amount of bone happened. Su-turing was done with silon sutures. Post-extraction care was provided, when appli-cable, consisting typically by treatment of post-extraction alveolitis.

Treatment of dental problems during expeditions

Description and the treatment of dental cases that happened during the expedition time are summarized in Table 1 for Czech Antarctic expeditions and Table 2 for Brazilian Antarctic expeditions. In short-term Czech Antarctic expeditions, there were 5 cases recorded during the period of 2007-2023. Since the average number of expedition crew is 18 people per expedition, the 5 cases related to the overall number of

expedition participants of 306 people. Data on dental care in Brazilian crews are typical of the care provided (1) during transport and/or service of the crew on board of the icebreaker (Ary Rongel), a vessel with a capacity of 70 crew members and 22 scientific staff members. This part of dental service is provided during the operation of the Ary Rogel during the cruise in Antarctic waters. An important aspect of the on-board dental care is the fact that it was provided to the international community of scientists traveling on board the ship (Table 2 - *e.g.* Polish and Chinese treated in 2021) The other part of dental care (2) is provided at the Brazilian Antarctic station Comandante Ferraz, a permanent station located in the Admiralty Bay, King George Island (Antarctica).

Case No.	**Mendel station, James Ross Island Case description**	**Treatment**
1	fracture of the upper right central incisor distally	The first aid provided at the station was brushing the sharp end with an abrasive strip. Treatment: Restoration of the missing part of the tooth by a composite filling was done after the patient returned to the Czech Republic at a dental clinic.
2	loosing of permanent filling from the first lower right molar	Since the patient felt pain, a temporary filling approach was applied at the station. After closing the cavity with temporary filling, the tooth was without any pain, or other clinical symptoms.
3	nonspecific pain reported by crew members in the upper jaw (2 people)	The first man felt a pain in the upper jaw on the right side. The second man felt a pain in his lower jaw on the left side. A percussion test was applied and, it was negative. In spite of the fact that no relievers were applied, the pain faded away and no problems were reported after 24 h.
4	loosing of upper central left incisor abutment and crown	There was no first aid because the instruments needed for fixing abutments to the implant were not part of the first aid equipment (dental instrumentarium) available at the station. The problem was dentally treated after the expedition when a patient returned to home city.
5	loosening of the dental cavity filling, first lowr left premolar	The incident happened three days after the arrival to the station. The patient lost his cavity filling in a pretty much devastated dental environment. The sanitation was performed immediately after oral hygiene and local disinfection by the application of temporary filling fast-solidifying paste. The filling successfully lasted until the end of the mission.

Table 1. Overview of dental cases at the J.G. Mendel station (Czech Antarctic Programme) and treatments apllied within the period of 2007-2023.

2018
There is no record of dental care.

2019
Summer - 10 (ten) appointments performed by NApOc dentist Ary Rongel.
Note: The reasons were not described.
Winter - There is no record of dental care.

2020
There is no record of dental care.

2021
Summer - 23 (twenty-three) appointments performed by NApOc dentist Ary Rongel, 19 (nineteen) military, 02 (two) Chinese, 01 (one) AMRJ and 01 (one) Polish.
Note: The reasons were not described.
Winter - 04 (four) visits were carried out by the EACF doctor on a palliative basis, 01 (one) tooth fracture and 02 (two) block repositioning, and 01 (one) with a tooth abscess.

2022
Summer: -12 (twelve) appointments performed by NApOc dentist Ary Rongel.
Note: The reasons were not described.
Winter - 03 (three) treatments performed by the EACF doctor on a palliative basis, two uncomplicated tooth fractures, and 01 (one) block repositioning.

2023
Summer - 21 (twenty-one) appointments performed by NApOc dentist Ary Rongel. There were 17 (seventeen) cleanings and preventive assessments in preparation for winter, 01 (one) block repositioning, and 3 (three) fillings that needed to be redone.
Winter - 03 (three) treatments performed by the EACF doctor on a palliative basis, one uncomplicated tooth fracture and two gingivitis.

Table 2. Overview of dental care provided by the Brazilian Programme in the period of 2018-2023. *Key to the abbreviations*: NApOc dentist – dentist on board of the Ary Rogel, EACF – dentist serving at Comandante Ferraz station.

Recent and future strategies in dental care in Antarctica

Information on medical care, frequency of diseases, and applied treatment are indispensable to the advancement of the medical system and research in Antarctica. For dentistry, a pre-expedition dental training program for the attending doctor is recommended. Moreover, based on recent experience (Ohno et al. 2012) telemedicine for both diagnosis and treatment of dental problems is recommended for future expeditions. Recently, telemedicine strategy and infrastructure modularization have been optimized for Antarctica, especially for traumatic events in the orofacial area. Most recent experience from BAS is overviewed by Lowe and Warner (2023) and reports the following main areas: consultations held by station medical staff and dental experts in the home country using an exchange of digital radiographs and digital images leading to specialist advice from dental and oral surgeons in order to guide

treatment or to determine if evacuation for specialist care is needed.

Apart from treatment at the stations that might be insufficient due to limitations in instruments or lack of experience by medical staff, transport to other stations and/or outside of Antarctica might be an option. Mill and Mills (2008) reported dental problems as a reason for evacuation from the US Antarctic base. This was rather exceptional because the same authors reported that approximately 30% of the evacuations were caused by emergencies related to internal medicine issues. Alternatively, dental care provided on board of ships (Hoyme and Meyer-Rochow 2011, Carron et al. 2018) might help in the treatment of people with acute dental and/or orofacial problems. Such an approach is applied both in the treatment of acute dental problems as well as a precautionary measure when the expedition crew travels to the destination (Antarctic station) on a ship operated by a national Antarctic program (*see* Ary Rongel in Table 2 – Brazilian Antarctic program).

Some Antarctic programs have equipped their Antarctic stations with dental units so that they now reach the standard of dental clinics. US and Australian programs are typical examples of a high standard of dental care provided at permanent stations. In McMurdo station, the dental clinic, housed in the medical building[1], contains the supplies and equipment that an experienced dentist would need for dental care (Iserson 2019). The McMurdo clinic was equipped so well because earlier (before the establishment of the clinic), the dental care was limited for both McMurdo patients and those flown in from the South Pole throughout the austral summer season. Nowadays, a wide range of dental care might be provided, and there is no need to send the patients to New Zealand for dental care. Available dental procedures include taking dental X-rays and e-mailing them to the consulting dentist for evaluation, doing dental extractions, and using powered dental tools. Australian permanent station Casey is also well equipped with dental chair and equipment. Australian Antarctic Division (AAD) uses mobile medical and dental X-ray equipment to provide medical and dental care at Casey, Davis, and Mawson stations as well as on the supply ship Aurora Australis (Lugg and Ayton 2012, [2, 3]). Professionals who operate the X-ray equipment undertake relevant training in order to carry out medical or dental radiography. Moreover, the AAD gives medical doctors two weeks of dental training before they head to Antarctica. Recent review of Lecordier et al. (2023) reports that 13 countries provide practical training for dental surgery for medical doctors heading to Antarctica. Importance of such training was emphasized recently by Mi et al. (2023). A recent trend is that all permanent Antarctic research stations should offer dental medical care and telemedicine capabilities (Ting and Wilkes 2021). Telemedicine plays a critical role in handling medical treat-ments at Antarctic stations and will be increasingly important in the future.

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