Extracting a tooth should be the last resort in space

An interview with former NASA dentist Dr Michael H. Hodapp, USA

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A toothbrush of Buzz Aldrin, a crew member of Apollo 11 and one of the first humans to ever walk on the moon, was recently auctioned for US$22,705. Fifty years later, astronauts are still using everyday oral care products on their missions. DT Group Editor Daniel Zimmermann spoke with former NASA dentist Dr Michael H. Hodapp, USA, about his work, the possibility of dental emergencies in space and how to maintain good oral health on future long-term missions to Mars.

Daniel Zimmermann: Do you know how many dentists are currently employed by the agency?

Dr Michael Hodapp: Owing to the recent cutbacks to NASA’s budget, they have closed the NASA dental clinic, so there are no dentists contracted by the agency at this point. Astronauts seek dental care from private practitioners, and are followed closely by NASA-employed flight physicians.

Dr Hodapp, how did you become involved with NASA?

In 1994, another dentist working for NASA informed me that a position had become available to care for the astronauts and their families at NASA, and asked me if I would be interested. After a series of interviews, I was appointed to the position. I served NASA as a contractor for more than a decade before I went back into private practice in 2004. However, I am still called on occasionally as a consultant for dental issues aboard the International Space Station (ISS) and future exploration-class missions.

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How important is oral health for astronauts in general?

Oral health is a primary concern for astronauts and goes hand in hand with general health. All astronaut candidates are initially screened for dental issues prior to selection, and all those selected are expected to adhere to a meticulous oral hygiene routine and maintain good oral health. The primary goal is prevention. Yet, even with the highest standards in prevention, the potential for a dental emergency in space still exists. A recent analysis of all medical conditions determined that the one condition most likely to result in departure from the ISS is a dental abscess.

Russian cosmonaut Yuri Viktorovich Romanenko had to go through two weeks of incapacitating tooth pain during the Salyut 6 mission in 1975. When were dental emergencies first included in mission protocols?

Unfortunately for Romanenko, according to reports, the Soviets did not have a dental contingency protocol at that time. The Russian space programme has since made provision for such emergencies, however.

During the US Mercury programme, the flights were so short that there was no need for an in-flight dental emergency protocol, and prevention was the primary focus. Owing to the extended time spent in space during the Gemini programme, a toothbrush was added to flight kits as a preventative measure. Apollo missions then incorporated a digestible dentifrice and floss, as well as antibiotics. Instrumentation like forceps and temporary filling materials was first introduced when the Skylab space station was launched into orbit in the early 1970s and has been part of the emergency kits ever since.

How frequently are astronauts given pre-flight check-ups?

Astronauts undergo pre-flight exams 18 to 21 months before launch. During this exam, the astronaut undergoes a thorough clinical and radiographic exam, including bitewing and panoramic X-rays. All necessary treatment is then to be completed 90 days prior to launch. The astronaut undergoes an additional exam to rule out any hidden pathology or any unreported recent oral injuries 50 to 90 days before launch. The astronaut is also expected to follow a meticulous oral hygiene routine during flight.

No in-flight dental emergency has ever been reported by NASA. What kind of problems do you think are most likely to occur?

While the chances of a dental emergency occurring in space are low, the potential is always there. For instance, when astronauts move large objects, the inertia of mass and velocity can potentially cause facial injuries and result in either a medical or dental emergency or both. Besides breaking a tooth, other considerations include laceration, crushing, grinding, split teeth or the fracturing of a cusp while chewing. Even with the most meticulous dental exam and hygiene programme, there is always a possibility that a tooth abscess could form due to trauma, hidden caries or a failing root canal.

Which dental emergencies are astronauts trained to handle by themselves?

There are two crew medical officers (CMOs) aboard every mission and they are trained to perform a number of dental and medical emergency procedures. On board, CMOs have the capability to treat with antibiotics and analgesics, administer anaesthesics, place temporary dental fillings, replace a crown with temporary cement, treat exposed pulp, and as a last resort, extract teeth. Any emergency treatment would include communication with ground support flight physicians, as the CMOs are non-physicians or dentists themselves. However, since the ISS is in low earth orbit, a true emergency situation would likely result in a return to earth for proper treatment.

Future missions will take astronauts to other planets in the solar system, like Mars. How do you think that these long-term flights pose regarding oral health?

We still do not know the long-term effects of space flight on the teeth, alveolar bone and periodontal health. It is well documented that during space flight bone mineral density decreases in weight-bearing bones. It is not clear how this affects the teeth and alveolar bone and whether crew members are more susceptible to tooth decay or periodontal disease.

Skylab oral health studies determined that there were increased counts of caries-producing bacteria such as Streptococcus mutans among crew members. It was concluded that this was due to the dehydrated diet that astronauts consume. This could be a potential contributor to oral health issues during extended missions, especially if a crew member begins to lapse in proper oral hygiene.

Dental emergencies in space would be challenging to handle as well. A mission to Mars would require at least a 2-year flight duration of six to nine months. Owing to the alignment of earth and Mars, the nominal round trip would spend either 50 days or a year and a half on the Martian surface. Were an oral emergency to occur during the outbound flight, there would not be a safe-return-to-earth capability. Not enough fuel could be carried to counteract the forces of launch that propel the crew on their voyage. In essence, all emergencies would have to be handled by the CMOs either in flight or on a planet with a little more than one-third of the gravity of earth.
In space, “for every action, there is an opposite and equal reaction” has special meaning to the treating CMO and the crew member receiving treatment. Just the act of giving an injection would send the crew member and CMO darting away from each other if proper techniques were not followed. The luxury of gravity does not exist, and simple procedures can become major challenges without it. Consider for a moment trying to give CPR without the force of gravity holding you in place.

Working in the oral cavity poses special concerns, since the very act of breathing not counteracted by gravity would have a tendency to draw anything loosely held within the oral cavity back into the lungs.

There is also the concern of the limited medical skills of CMOs, and the one-way communication delay with ground support of 20 to 25 minutes. In other words, it could take 45 minutes for a flight physician to deliver instruction to the treating CMO. Prayers would be in order for the afflicted crew member.

What measures are being considered to overcome these problems?

Recent discussions in relation to exploration-class missions have proposed instrumentation for semi-annual dental exams and cleaning for each crew member, as well as additional equipment for the diagnosis and treatment of dental emergencies. Some of the equipment considerations include a high-definition intra-oral camera system, a method for detecting interproximal decay and osseous infections while limiting radiation, as well as a battery-operated dental handpiece and headlight.

Material considerations include an intermediate restorative material that is easy to use, does not require special equipment for mixing or curing, releases fluoride, and could last for the duration of an exploration-class mission. The US Navy is currently conducting research on a restorative material that fits this description. A glass ionomer restorative material is also under consideration, although this would require special packaging to allow for controlled mixture by hand in a microgravity environment.

Discussion about medications indicated that all drugs would need to be freshly manufactured and would require special packaging to maximise shelf life, especially those medications that are sensitive to moisture and radiation.

Software considerations include training videos for the crew members to review and train to keep abreast during their travel.

President Obama speaks of sending humans to Mars as early as 2018. Do you believe that these plans are realistic? It is my understanding that there are no definite plans for a manned mission to Mars in the near future. Recent cuts to NASA’s budget have slowed progress for a manned mission to the red planet. Our closest neighbour is explored using robotics, and there is much to learn about Mars prior to risking the lives of humans on such a distant journey.

However, planning and research for manned exploration-class missions is still being conducted, and the Orion project is still in progress. There are so many hurdles to overcome before such a journey could be undertaken.

Currently, NASA is formulating plans for a three-month mission to rendezvous with a near-earth asteroid. This would be a scientific mission requiring a one-month flight to rendezvous with the asteroid, conduct research and fly back to earth.

If NASA offered you the opportunity to go to space, would you accept it?

Since I was a young boy I have looked to the heavens and been fascinated by its beauty and have always dreamt of going into space. Given the opportunity, I would go in a heartbeat.

Thank you very much for this interview.