

Saturation Diving Chamber Hygiene

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1 Introduction

Infection is the most frequent medical problem encountered during saturation diving. The closed environment, temperature, humidity, hyperoxia and helium environment contribute to enhanced microbial growth. Superficial infections, especially of the external ear canal and of soft tissues following minor wounds, are particularly common. The sources of microbial contamination of the chamber include the divers themselves, equipment, food, materials introduced into the chamber, the fresh water supply, and seawater. Control of microbial growth within the chamber is important in minimising episodes of infection.

This guidance note considers those few microbes of particular relevance to saturation diving (certain bacteria, and, to a lesser extent, some fungi and viruses) and describes measures to prevent/discourage infection by them.

This guidance note will be updated as indicated by the rapid increase in knowledge concerning microbes.

2 Microbes and Saturation Diving

2.1 Bacteria

Predominant among the many microbes present in a saturation system environment are Gram-negative bacteria – principally the pseudomonas and the coliform (e.g. proteus, klebsiella and E. coli) groups. The pseudomonas group is a natural inhabitant of fresh and seawater, and can thus readily enter a saturation system. The main source of coliforms is faecal excretion, therefore the organisms are an inevitable contaminant of chambers.

Skin and other superficial infections from Gram-negative bacteria are more common in the hyperbaric environment than in normobaric conditions. Notwithstanding the wide range of microbes in the chamber complex, the majority of superficial infections (including that of the external ear canal - otitis externa) in divers are caused by one single species – *Pseudomonas aeruginosa* (formerly known as *Pseudomonas pyocyaneus*, hence 'pyo').

2.2 Fungi

Fungi and their spores are widespread, and, like Gram-negative bacteria, grow well in warm and humid conditions. Some fungi are normally present on human skin, and in saturation conditions these are more likely to cause superficial infections, e.g. 'Athlete's Foot'. (Fungi can cause a variety of other infections, but there is no predisposition to them in the hyperbaric environment).

2.3 Viruses

Viruses, which spread from human to human by a variety of routes, cause several of the most common infectious illnesses. Viruses causing respiratory infection are most frequently transferred by airborne droplets produced by, for example, coughing, sneezing. Droplet spread in the confined chamber community can result in transmission of unwelcome but not serious infection, e.g. the common cold.

The HIV and Hepatitis B viruses are spread by direct contact with the body fluids of an infected individual (principally blood to blood). Though sensible and normal hygiene practices (summarised below), ensure risk of infection no greater in hyperbaric than normobaric conditions, these two viruses receive this mention as they necessarily have received considerations specific to diving.

3 Measures to Safeguard Against Infection

Consideration is given to personal hygiene, both general (common to normobaric and hyperbaric conditions) and specific to saturation diving, to prevention of infection of the external ear canal, and to chamber and equipment cleansing routines and environmental control.

3.1 Personal Hygiene Measures

A high standard of personal hygiene is important.

Divers should be free from infection before being committed to saturation.

Regular showers are advisable throughout saturation - at least once daily and increasing to before and after each dive lock out. The diver should use a neutral or slightly acid soap to prevent destruction of the protective bacteria on the skin. The ears should be kept dry during showering to reduce the possibility of bacterial growth and soap remnants in the external ear - readily achieved by, e.g., occluding the entrance of the canal with clean gauze smeared with vaseline. Regular changes to clean, non-restrictive and comfortable clothing protect the skin.

Lock-out of used clothes and towelling, etc, should not be delayed. Such items should be laundered at a high temperature of minimum 85°C.

Bedding should be changed regularly.

Persistently wet or abraded skin and minor wounds and burns greatly increase the risk of infection. Even minor wounds need regular meticulous cleaning and covering. (The attendant should wear disposable gloves). Waste associated with cleaning and dressing should be put into plastic bags for early lock-out.

Nails should be cut at right angles to fingers and toes. Attempts to cut at ingrowing toe-nails or corns risk sores and infections.

Armpits and crotch need a clean and dry regularly.

Shaving should be avoided or limited if the skin of the beard area is irritated.

Regular visits to the dentist and good brushing of teeth (thorough brushing of all surfaces of all teeth takes a few minutes dedicated to the task) at least twice a day are the cornerstones of avoiding most, including infection, dental problems. Dental floss is a valuable aid.

Sharing of razor, toothbrush, comb or towel is ill-advised. There is no need for personalised eating and drinking utensils, though a drink should not be shared from the same cup. Unused food and drink should be locked-out without delay.

With particular reference to blood spillage, but applying also to vomit, diarrhoea, etc, the principles are to clean up thoroughly using disposable gloves and paper cloths, soiled materials into plastic bag for early lock-out and to treat the wiped surface with washing followed by chamber cleanser (considered below).

As far as is possible, divers should retain diving equipment as personal, e.g. undersuit, suit, headliner. It is not practicable to personalise helmets, and all that can be done between dives is a wipe and rinse. The oro-nasal mask and nose block pads, however, clearly a significant potential source of infection, can be removed from the helmet after each bell run and surfaced (to be washed, treated with chamber cleanser, rinsed and dried). The practical constraints likely preclude personalising the oro-nasal by means of changing it between dives during one bell run. Neck dams may require to be cleaned in the bell. Particular care should be taken with items which will be in close contact with the diver's skin to ensure

that any cleanser (which may irritate the skin) is washed off adequately before re-use. Suits, etc, should be cleaned and dried on the surface between dives.

There is no need to go beyond these simple, personal and routine measures unless circumstances have required guidance on further actions.

3.2 Prevention of Infection of the External Ear Canal

Prophylactic ear drops containing acetic acid and aluminium acetate (Domeboro otic) are designed to minimise the chance of infection by maintaining the external ear canal acidic. With the head leaning to one side, and without allowing the nozzle of the dropper bottle to touch anything, 3-4 drops are placed into the external canal of the ear. The drops should be used for a timed minute in each ear twice daily and following each dive/shower. Divers should retain two bottles for personal use, one for each ear and labelled accordingly.

3.3 Chamber Cleansing and Environmental Control

Chamber cleansing is designed to limit microbial growth (particularly the predominant Gram-negative bacteria) and, therefore, to protect against infection.

Cleansing (with liquid anti-microbial - specific agents considered below) is started at the top of the chamber and is continued downwards, with excess cleanser ultimately drained from the bilges. Relays of fresh cloths / sponges should be used on each occasion and discarded after limited use.

Before a saturation dive, the entire chamber (including e.g. service locks, "rims" of toilets, bunk brackets) is most thoroughly cleansed (with the deck plates lifted), and allowed to dry. The parts of the chamber which will be in direct or indirect contact with the skin (e.g. shower-deck, sink, tables and BIBS masks) and other personal equipment e.g. headsets, should be disinfected using chamber cleanser, left for a minimum of 10 minutes, then rinsed and dried thoroughly. Shower-heads should be removed, cleansed, rinsed after 10 minutes, and dried. The chamber should be ventilated and clean bedding and towels provided.

During saturation, the toilet, sink and shower areas, service-locks and their immediate areas, and table surfaces should be cleansed daily. Twice weekly, chamber walls and bulkheads and BIBS masks, etc, should be cleansed, and shower-heads removed for cleansing on the surface.

Bilges or floor areas beneath deck plates should be drained of cleanser, but should not be actively cleansed or otherwise disturbed.

Shower areas should be drained quickly after showering and the floor retained dry.

3.4 Chamber Disinfectant Cleansers

Several agents are in use or recommended. These include "Panacide M", "Tego 103G", "Tego 2000", and "Trigene". Various other products may also be suitable.

The prime requirements of the disinfectant agents is that they should be very effective against the microbes known to flourish in the chamber environment and be non-toxic to man. Additionally, the disinfectants should be odourless, non-volatile, and be free from irritant and sensitising properties.

"Panacide M" is now less used than formerly because of its undesirable properties of strong odour and skin irritation. The Tego products are increasingly being used, and combine good anti-microbial properties with relatively few disadvantages, e.g. they are odourless and less likely to be irritant to the skin.

All chamber disinfectants should be used at the appropriate dilution, skin contact should be minimised by the use of personal protective equipment, and they should be applied by cloth or sponge to avoid the formation of an airborne aerosol.

3.5 Environmental Control

Safeguarding against infection within chambers involves control of humidity (which should be maintained at the dry end of the range of comfort), the use of hot water at no less than 60°C for cleaning and meticulous conduct of the onboard procedures to ensure the purity of the fresh water supplies. Samples of potable water should be tested by a laboratory before committing to, and at regular intervals during, saturation.

4 Further Measures

Routine swabs for microbe analysis from the ear canals of divers are not advisable. Rather, such swabs should be reserved for use in divers with clinical features of otitis externa, such as pain, itch, discharge. However, routine swabs from chamber surfaces both pre-dive and during saturation are helpful as guides to efficacy of cleansing regimes.

It is essential to use the correct swabbing technique - the swab bud on the end of the stick should touch only the part to be sampled, and nothing (including fingers) should touch the swab stick.

As a generalisation, the extent of chamber contamination and risk of episodes of infection increase with the duration of the dive, particularly when chamber complexes remain at pressure for long periods. When such operations are planned, intermittent surfacing of individual chambers for cleansing and drying is beneficial in controlling chamber contamination.