Medical Memoranda

Asphyxia with Nitrogen

A case of asphyxia with almost pure nitrogen under pressure is reported because of its rarity and because cases of a similar nature are likely to become more frequent as "free" diving with self-contained underwater-breathing apparatus (S.C.U.B.A.) becomes an increasingly popular pastime.

CASE REPORT

A licensed aircraft engineer aged 29, a keen and experienced "free" diver, flew round the world. While at Honolulu airfield he asked an airfield technician to refill his 750-litre cylinder with air to a pressure of 150 atmospheres.

The cylinder was painted grey with a black-and-white band at its upper end, and was clearly labelled "AIR" (see photograph). In due course the cylinder was returned to him and he came back to this country with it and the rest of his underwater - breathing apparatus.

Two weeks later he went "free" diving at the local swimming - baths. After boasting to his friend about his "fresh air from Honolulu" he adjusted his equipment, took a few breaths to test the valves, then entered by the ladder at the deep end—6 ft. (1.8 m.)—breathing through his open circuit apparatus. He remembers striking out from the side of the bath that something was wrong, before becoming unconscious. He remained underwater for only about 30 seconds before his companion realized he was unconscious.

He was quickly and easily brought to the surface, but difficulty was experienced in lifting him to the side of the bath, and his right forehead was then bruised. He was noticed to be intensely cyanosed, especially in his neck, and his mouth was closed tightly on the mouthpiece of the apparatus. He vomited and defaecated almost at once after removal from the water.

Artificial respiration was begun by Schafer's method, and oxygen was administered shortly afterwards by ambulance attendants, who were quickly on the scene from their ambulance station immediately opposite the public swimming-baths. When seen, about 20 minutes after the accident, his behaviour was very similar to that seen in recovery from nitrous oxide anaesthesia. He was stuporous, but could answer his name, repeating it many times. He repeated, "I have been drowned; I am all right," and burst into laughter.

His temperature was 97° F. (36.1° C.), pulse 108, and B.P. 150/90 mm. Hg. There was a superficial bruise on his right forehead. Subconjunctival haemorrhage had occurred in the lateral aspect of his right eye, and pinhead ecchymoses were seen in his right sclera. The pupils were equal and dilated, and reacted to light. The fundi were normal. His cranial nerves were normal, and the only abnormality evident in his central nervous system was that his reflexes were all brisk.

During the next 12 hours his level of consciousness rose to normal. He vomited two or three times. Subconjunctival haemorrhage was evident in both eyes, such that the whole

of the sclerae were suffused with blood. He had diplopia and difficulty in focusing. Otherwise he was well and able to get up to go to the toilet. Thirty-six hours after the accident he was discharged home, where he remained symptom-free. His subconjunctival haemorrhages were still obvious three weeks later but were resolving peripherally.

Subsequent analysis of his "compressed air" cylinder showed that it contained oxygen 0.5%, nitrogen 99.5%, carbon monoxide nil. In fact, his cylinder had, by mistake, been filled with nitrogen at Honolulu.

Nitrogen, used commercially as an inert gas for pressurizing aircraft petrol tanks, is stored in cylinders coloured grey (B.S. Colour No. 30) with a black band lettered with the symbol "N." Air is stored in cylinders of identical grey colour, but with no black band or symbol. Both cylinders have a right-hand screw thread. It is easy to understand how this mistake in identification of cylinders occurred.

To conclude this unusual record of chance occurrences it seems reasonable to report that the patient was tragically killed five weeks after this incident in an air crash in the Libyan Desert.

DISCUSSION

The points of interest and the lessons to be learned from this case are as follows.

1. Nitrogen is present in atmospheric air at about 79%, and is an inert odourless, colourless gas. Sudden exposure to air containing less than 4% of oxygen causes loss of consciousness, with hardly any warning symptoms, within about 40 seconds (Hunter, 1957). Francheteau (1954) describes the rapid onset of unconsciousness occurring in three men who entered atmosphere containing 96% nitrogen, and Wright (1940) states that unconsciousness develops suddenly in 45 seconds if pure nitrogen is inhaled. In the case reported unconsciousness occurred in less than 60 seconds after breathing pure nitrogen. A simple safety precaution can immediately minimize the dangers of a repetition of this accident. It is recommended that all "free" divers using S.C.U.B.A. breathe through their apparatus for a timed 60 seconds, observed by a companion, before they enter the water. If their cylinders are charged with pure nitrogen by mistake they will become unconscious in that time, and their companions will have a relatively easy task reviving them.

2. The accident reported is analogous to the "mistaken cylinder" accidents of anaesthesia, the incidence of which has been reduced by strict care in the identification of cylinders by their colouring and labelling. Commercially, care is taken also, and distinctive colours and left-hand threads are used for the cylinders of potentially explosive gases. Air and nitrogen cylinders, however, are a similar grey colour. A change of nitrogen cylinders from grey to a more distinctive and alarming colour is recommended.

3. It seems reasonable to assess this patient's symptoms and signs as resulting from three factors: sudden unconsciousness due to anoxia; subsequent behaviour due to nitrogen intoxication ("nitrogen narcosis"—Hunter, 1957); and his subconjunctival haemorrhages due to local "squeeze" (Lanphier, 1957), a pressure effect similar to suction produced in his face-mask while he lay unconscious under 6 ft. (1.8 m.) of water.

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The cylinder concerned.