

# The diving doctor's diary

## A case of diving-induced pulmonary oedema

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### Key words

Immersion, pulmonary oedema, scuba diving, case reports

### Abstract

(Glanvill P. A case of diving-induced pulmonary oedema. *Diving and Hyperbaric Medicine*. 2006; 36: 198-200.)

An interesting case of acute immersion pulmonary oedema in a fit middle-aged woman is presented. Intermittent dyspnoea and cough occurred over a seven-year diving history in temperate but not tropical waters. Cool surface weather conditions prior to symptomatic dives may have been a contributing factor.

C, a married pharmacist aged 48, originally contacted me in late August 2001, after encountering medical problems relating to a recent dive.

She had a history of rheumatic fever aged 12, which resulted in restricted physical activity for several months and then her taking penicillin for about two years. There were no apparent sequelae. Several years previous to contacting me she sustained a depressed fracture of the facial bones necessitating surgical repair of both malar and nasal bones, including metal and plastic prostheses, with a satisfactory cosmetic result. She took no medication. She made a point of keeping physically fit with a variety of activities including regular visits to the gym and yoga. Family history is interesting in that her mother always refused to swim in UK waters telling her children she got the "dreaded lurgy". When her daughter was older she told her that she fainted if she entered cold water although could swim in the warm waters of the Mediterranean. Her mother was a physically active individual having been a ballet dancer and is still alive and well. C's daughter has problems when eating ice cream – it makes her feel short of breath.

C learnt to scuba dive in 2000 in Mexico and Thailand and then made a few dives in the UK, none of which she described as being "successful" (Table 1). She found concentration difficult during the dives, which she made in a 7 mm semi-dry suit. At the time she attributed the problems in concentration to difficulty in adapting to the more cumbersome nature of the suit and the extra weights that were required.

Four days prior to contacting me in 2001 she had dived with normal scuba gear, breathing air, to a maximum depth of 18 msw off the south-west Cornish coast (sea temperature 15 °C) – her fourth UK dive. After 15 minutes she ascended from 18 metres, making a fairly rapid journey from 10 metres to the surface as she had lost concentration completely and "felt strange". She then became acutely breathless, felt fatigued and coughed up pink, frothy sputum. She had

no neurological symptoms, surgical emphysema or voice changes. She was given oxygen and transferred by boat to shore and then by ambulance to the nearest hospital. She says her oxygen saturation was reportedly low at transfer and that inspiratory crackles were apparently heard over the lungs. She was treated with oxygen and intravenous frusemide. Within four hours her symptoms had remitted and she felt well, with normal blood pressure and oxygen saturation. A chest X-ray was taken on admission and she reported that it showed "fluid on the lung".

She had contacted me because she wished to know when she could return to diving. My initial reaction was that she had had pulmonary barotrauma, but I also wondered about transient pulmonary oedema. Subsequent examination by a chest physician who had some knowledge of diving medicine could find no evidence of pulmonary abnormality and he advised her that she could recommence diving. During the following year she dived uneventfully in the Red Sea and the Far East (Table 1).

She next contacted me in May 2002 after a dive to 14 msw in Portland Harbour, Dorset (sea temperature 13 °C). Coincidentally she was with the same dive buddy and boat skipper as at the time of the previous episode.

She felt unwell at 20 minutes, breathless at depth after 25 minutes and, after a rapid ascent, coughed up pink, frothy sputum on the surface. She was given oxygen and a helicopter transfer to a recompression facility at Poole only 20 minutes away. She was not recompressed but observed overnight having been given intravenous frusemide and oxygen. She felt that the diuretic therapy made her feel worse by dehydrating her. Those treating her were reported to be mystified as to the cause of her symptoms.

I now felt certain she was suffering from cold-water-induced pulmonary oedema and sought the advice of Dr Peter Wilmshurst, consultant cardiologist and member of the UK Sport Diving Medical Committee, copying the enquiry to

her general practitioner who would have to make any formal referrals. In the event she was referred back to the chest physician who had seen her previously.

He performed full lung-function tests and an echocardiogram, all of which were normal. He was not aware of the syndrome of cold water pulmonary oedema but felt that she was clearly putting herself at considerable risk by continuing to dive. C decided to continue diving at her own risk with a full-face mask. This was the state of play in July 2002.

In October 2006, preparatory to this report, I contacted her with regard to her subsequent diving activities particularly in view of the four-year lapse our last contact.

She reported that she had taken her advanced open water PADI course in the UK using a full-face mask and had experienced no problems with dives up to 24 msw in water temperatures ranging from 15 to 18 °C for dive times of up to 40 minutes. She had also dived in Bali, Lombok and the Maldives using ordinary scuba diving equipment for these warm-water dives (Table 1).

Finding the full-face mask uncomfortable she decided to try a dive in the UK with a ‘big eye’ mask supplemented with a dose of antihistamine (acrivastine) taken 15 minutes prior to the dive. During the summer of 2003 she continued diving in the UK and later in the year dived in Kenya (Table 1).

She did not do any foreign diving that winter but started UK diving again in the summer of 2004 using the large mask/antihistamine combination that appeared to have been successful the previous season. Her first dive on a cool, overcast evening (17 °C) ended in her feeling slightly short of breath with a cough, but she was asymptomatic on three subsequent dives in water of 16 °C. At the end of 2004 she spent a week diving in Egypt (Table 1).

In 2005 she again did no diving until July when, after five uneventful sea dives in the UK, she dived on a cool evening to a depth of 16 msw for 40 minutes in a water temperature of 18 °C. Thirty minutes into the dive she described herself as feeling “very strange” and then developed a cough and dyspnoea. She clipped herself to her buddy and they made a controlled ascent. After breathing oxygen on the surface she

**Table 1**  
**Record of patient’s diving experience 2000–2006 (WS – wetsuit; SDS – semi-dry suit; DS – dry suit)**

Year	Location	Sea temp < 19 °C	No. of dives	Symptoms	Equipment	Comments
2000	Mexico and Thailand	No	17	Nil	Scuba + 5 mm WS	Training dives
2001	UK	Yes	3	Poor concentration	Scuba + 7 mm SDS	First cold-water dives
	UK	Yes	1	Loss of concentration, exhaustion and breathless on surface, pink sputum	Scuba + 7 mm SDS	Rapid ascent from 10 msw Treated by evacuation, O <sub>2</sub> and diuretics.
2002	Red Sea	No	15	Nil	Scuba + 5 mm WS	
	Sipadan	No	20	Nil	Scuba + 5 mm WS	
	UK	Yes	1	Malaise, breathlessness underwater, pink frothy sputum on surface	Scuba + 7 mm SDS	Helicopter evacuation to hyperbaric unit. Treated with IV diuretics and O <sub>2</sub>
2003	UK	Yes	15	Nil	Full-face mask + 7 mm DS	Advanced PADI open water training
	Bali/Lombok	No	19	Nil	Scuba + 5 mm WS	
	Maldives	No	25	Nil	Scuba + 5 mm WS	
	UK	Yes	9	Nil	‘Big eye’ mask + 7 mm SDS	Pre-dive acrivastine
2004	Kenya	No	17	Nil	Scuba + 5 mm WS	
	UK	Yes	3	Slight breathlessness and cough on one dive	‘Big eye’ mask + 7 mm SDS	Low ambient temperature pre-dive + acrivastine
2005	Egypt	No	12	Nil	Scuba + 5 mm WS	
	UK	Yes	6	On sixth dive, malaise, cough and dyspnoea with pink sputum on surface	‘Big eye’ mask + 7 mm SDS	Pre-dive acrivastine. Oxygen and rest. Cool evening.
2006	Manado	No	20	Nil	Scuba + 5 mm WS	
	Egypt	Yes	10	Nil	Scuba + 5 mm WS	Nitrox dives – “Clearer headed” post dive

discussed the situation with the skipper (who had witnessed the previous two episodes) and declined an emergency evacuation to hospital on the basis that the symptoms were identical to those that had remitted spontaneously previously. She was driven home and had made a full recovery within four hours with no further treatment and returned to work the next day.

She has since dived in the Far East and in March 2006 did a nitrox course in Egypt with no problems. She has no plans to dive in UK waters in the future as she feels that the risk to herself and the inconvenience to her companions is too great, but she plans to continue diving overseas in warm waters where she has never been symptomatic. As she pointed out, the standard dive declarations do not mention immersion or cold-induced pulmonary oedema!

She made some observations of interest on her symptoms in that prior to the episodes of dyspnoea she was aware of feeling vaguely unwell with a loss of concentration. She had also noticed that the air temperature appeared to have some influence on her attacks of oedema in that they had all occurred when she had dived after being exposed to lower than normal ambient temperatures prior to the dive. She also observed that after using nitrox she felt much livelier than she had breathing air, which leads me to suspect she was suffering from mild hypoxia on more UK dives than she realised but was able to compensate due to her physical fitness and increasing experience. Peter Wilmshurst (personal communication) observed one very physically fit diver (a marathon runner) with a large right-to-left shunt who could tolerate a remarkably low oxygen saturation, suggesting that there is a process of adaptation presumably akin to that occurring in high-altitude climbers.

### Commentary

The phenomenon of diving-induced pulmonary oedema is still not well recognised and, in this case, it was only after the second episode that the problem was diagnosed. The trigger in this case appears to be exposure to water colder than 19 °C and, more specifically, exposure of the facial skin to cold water. It is interesting that the episodes occurred not only in colder UK water but also, as the subject observed, on dives where she had been exposed to lower ambient surface temperatures either because of a long boat trip to the dive site in a cooling wind or because the dive was conducted in cooler conditions such as the evening. She has speculated that the presence of significant amounts of metal in her cheek bones might have increased her susceptibility. I suspect that the self-administration of antihistamine had little to do with reducing the number of episodes she sustained.

Previous case reports have described subjects with latent or undiagnosed disease but C remains in good health and specifically is normotensive. I think this makes her case particularly interesting.

It is also worth noting her comment that there is nowhere on a self-declaration form to indicate that one has suffered from this disorder and although it is rare perhaps this needs to be considered. She has made an informed decision based on her experience to continue diving, but only in warm waters.

Reviewing this case report caused me to consider that a number of unexplained diving fatalities could be the consequence of the diver developing pulmonary oedema. Nothing is more likely to induce panic and irrational behaviour than acute breathlessness. C's experience hints at the possibility that the phenomenon may also occur subclinically, the hypoxia resulting in poor decision making and again the possibility of error on the diver's part.

### Further reading

- Scubadoc's Diving Medicine Online. Pulmonary edema of diving [monograph on the Internet.] Available from: <<http://www.scuba-doc.com/puledem.htm>>. Accessed 31 October 2006.

This website describes the phenomenon of pulmonary oedema for the layman.

- Pons M, Blickenstorfer D, Oechslin E, Hold G, Greminger P, et al. Pulmonary oedema in healthy persons during scuba-diving and swimming. *Eur Respir J*. 1995; 8: 762-7.

This article describes a survey of 1,250 divers with 460 responders, only one of whom had a history suggestive of pulmonary oedema.

- Wilmshurst PT. Cardiovascular problems in divers. *Heart*. 1998; 80: 537-8.

The author describes cases of pulmonary oedema precipitated by diving. He recommends that affected individuals should not dive but that those who insist on continuing to dive should take nifedipine 5 mg pre-dive. At the time of writing this report he was not aware of any further episodes of pulmonary oedema occurring in those who took nifedipine pre-dive.

- Wilmshurst PT. Pulmonary oedema induced by emotional stress, by sexual intercourse, and by exertion in a cold environment in people without evidence of heart disease. *Heart*. 2004; 90: 806-7.

The author describes further cases of pulmonary oedema triggered not only by diving but also by emotional stress and sexual intercourse. He suggests a neurohumoral process producing flash hypertension and acute left heart failure as a possible mechanism.

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