Snorkelling deaths in Australia, 1987–1996

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Abstract

Objective: To examine the causes and circumstances of snorkelling deaths in Australia from 1987 to 1996.

Design: Retrospective case extraction.

Cases and data sources: 60 snorkelling deaths extracted from an ongoing diving fatality survey and from coroners' reports. Further details were obtained from police reports, diving industry (incorporating commercial operators, relevant government departments and instructors' organisations) inquiries and coronial inquests.

Main outcome measures: Cause of death (determined by the authors from information obtained and from detailed autopsy findings) and the circumstances surrounding death.

Results: 15 of the 60 snorkellers who died were female. The three major causes of death were drowning (27 cases), cardiac events (18) and hypoxia with breath-holding after hyperventilation and/or during ascent producing unconsciousness then drowning (12). Overseas tourists were notable among those who drowned, while middle-aged men dominated the group who died of cardiac events (mostly on the surface). Those who died of breath-holding hypoxia were all young, Australian and male. The use of "buddy" diving was infrequent overall, and many of those who drowned or suffered cardiac events were not wearing flippers to aid propulsion. Adverse environmental conditions were implicated in 14 deaths.

Conclusions: Hyperventilation to increase breath-hold time is a dangerous practice which should be discouraged. Safety measures, such as the use of flippers for propulsion and employment of the "buddy" system, should be encouraged, and made mandatory in commercial diving operations.

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There are very few demographic data available on snorkelling deaths in Australia. Although there are ongoing investigations into diving-related fatalities,[1,2] databases generated from these investigations are dominated by deaths associated with scuba diving[3-7] rather than breath-hold diving or snorkelling. This may be because scuba-diving deaths involve more exotic disorders (such as decompression sickness) and are more likely to attract coronial and media interest than snorkelling deaths.

We undertook this study because, as the popularity of snorkelling increases (especially on the Great Barrier Reef), the incidence of related fatalities is also likely to increase. Further, existing data and literature on snorkelling deaths are not readily available in the general medical literature. One study, by Walker, described 90 snorkelling deaths in Australia between 1972 and 1987.[1] We thus examined subsequent Australian snorkelling deaths that occurred from 1987 to 1996, inclusive.

Methods

From an ongoing study[1] into diving-related fatalities and by directly approaching the offices of State coroners, we obtained information on all available deaths where the victim was equipped only with snorkelling gear.

Further details surrounding each death (including environmental conditions, diving activities, rescue, first aid and resuscitation measures, demographic characteristics, snorkelling experience and past medical history) were obtained from police reports, diving industry inquiries and coronial inquests (including autopsy reports).

We then applied our current knowledge of diving physiology and medicine[8] to descriptions given by observers and the autopsy results to determine a cause of death in each case.

Results

We identified 60 snorkelling deaths in Australia during the study period. The three major causes of death were:

- ***Drowning*** (27 deaths, determined mainly from autopsy results, but supported by information from witnesses and resuscitation data where available);
- ***Cardiac events*** (18 deaths, determined almost entirely from the autopsy report and conclusion); and
- ***Hypoxia*** from breath-holding after hyperventilation and/or during ascent producing unconsciousness and then drowning (12 deaths, determined by the sequence of events prior to the death and information acquired about the victim's diving technique).

In three cases, the cause of death was either uncommon or unknown .

Age: The average age of the 60 snorkellers who died was 44.7 years (SD, 18.7 years). Those who died of cardiac events had a significantly higher average age than the group as a whole (56.6 years; SD, 14.6 years). The group who died of hypoxia was younger (35.2 years; SD, 14.9 years).

Sex: Fifteen of the 60 snorkellers were female. All the snorkellers who died of hypoxia were male, as were 15 of the 18 who died of cardiac events.

Status: Of the 27 who drowned, almost half were overseas tourists, at least 10 of whom were non-English-speaking. Nine

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of the 18 cardiac-event deaths also involved overseas tourists, mostly from the United States. By contrast, the 12 snorkellers who died of hypoxia were all Australians.

Experience: Of the 27 who drowned, 11 had no experience or were inexperienced, while eight were either experienced or very experienced relative to the circumstances in which they died. Nine of the 18 who died of cardiac events were very inexperienced and another three were specifically noted as being either very unfit or extremely weak swimmers — thus, at least 12 of this group would probably have had difficulty with propulsion. All 12 who died of hypoxia had a minimum of two years' diving experience; at least five were also scuba divers and one was an instructor.

Equipment problems: Flippers are necessary for propulsion in ocean currents, and weights are often worn to compensate for wetsuit buoyancy. Flippers were not worn by 11 of the 27 snorkellers who drowned and 16 of the 18 who died of cardiac events. Two drowning victims became entrapped in speargun lines and one was wearing a weightbelt with no quick release mechanism, while one snorkeller who died of a cardiac event was possibly overweighted. Most of the snorkellers who drowned remained on the surface after death and thus were not overweighted. Among the 12 who died of hypoxia, 10 were predictably well equipped, although eight were overweighted (this is a common practice among spearfishermen as it allows them to descend more easily), and nine sank after death.

Medical disorders: Of the drowning victims, three had epilepsy, three had asthma, one had bronchitis and emphysema. Five were also noted as being very unfit physically, usually because of major operations or illnesses. At least eight snorkellers who died of cardiac events had a history of cardiac disease, including cardiomyopathy (2), valvular disease (2), previous myocardial infarction (3) and a triple coronary artery bypass graft (1), and six were taking medication for hypertension and/or arrhythmias. Disorders affecting those who died of hypoxia included epilepsy (1), asthma (2), illicit drug use (2) and hypertension (2).

Contributory findings: Two of the 27 drownings were associated with vomiting, and in three there appeared to be some degree of saltwater aspiration before and contributing to the death. Saltwater aspiration and vomiting preceding death were also noted in some cardiac event deaths.

Circumstances: All 60 snorkellers were recreational divers; 35 were snorkelling from a commercial charter boat operation, and 15 were spearfishing. Only four snorkellers had a "buddy" diver accompanying them at the time of the incident: most were either diving alone (24), or had separated from others prior to the incident (28).

Eight snorkellers died in less than 1.5 metres of water, and 41 died in water five metres deep or less.

Cardiac event deaths seemed mainly associated with surface swimming; in at least 13 of the 18 deaths, the incident occurred on the surface and only two snorkellers were known to have descended under water prior to the incident, while two died in water in which they could have easily stood up.

The more experienced divers who died of hypoxia died in depths varying from 3–15 metres. Most of those who died of hypoxia did so either underwater or during ascent.

In 15 of the 18 cardiac event deaths, other snorkellers in the vicinity observed no evidence of difficulty, despite six snorkellers entering the water with a "buddy", four being observed by a supervisor at the time, and three being part of an organised group.

Environmental conditions: Adverse conditions were reported in association with nine drownings and five cardiac event deaths.

Rescue attempts: There were no attempts at rescue in 25 cases, and in 35 a rescue attempt was made, usually by a nearby swimmer. Rescue was initiated within five minutes (when resuscitation is feasible) in only 10 cases, and at between five and 15 minutes in 23 cases. Details of rescue attempts were unknown for the remaining two cases.

Cardiopulmonary resuscitation was attempted in 17 of the 27 drowning deaths (usually with oxygen and usually by paramedics or medical practitioners) and in 13 of the 18 cardiac event deaths.

Discussion

We found that many factors contributed to the three major causes of death. Many snorkellers who drowned were inexperienced, medically unfit, and often without flippers to assist in propulsion. The problem of salt water aspiration and drowning among divers has been reviewed recently.[9] Aspiration while still conscious causes a respiratory syndrome which is clinically evident as fatigue, dyspnoea, panic reactions, cough and occasionally vomiting. This can proceed to near-drowning or drowning. Some of those who drowned had asthma; the degree to which this may have contributed to the drowning is controversial and could not be determined. However, there is little doubt that asthma would have been aggravated and would have interfered with resuscitation efforts after aspiration of sea water.[8]

As in scuba divers,[3,7,8] cardiac deaths among snorkellers involved mostly middle-aged men. There are many aquatic factors that when superimposed on the underlying cardiac disorders often evident in the medical histories of the snorkellers who died may precipitate a cardiac event.[8] Inexperience, poor physical fitness, poor swimming ability and not using flippers for efficient propulsion — all increased the effort required for snorkelling.

Death caused by hypoxia from hyperventilation and/or ascent during breath-hold diving occurred in a younger, fitter group of divers — mostly spearfishers — who were very experienced and had good equipment. It was difficult to incriminate either equipment misuse or environmental hazards from reading the reports in nine of these 12 deaths. These divers commonly hyperventilate to increase their breath-hold time. Hyperventilation produces hypocapnoea, with no proportional increase in oxygen-carrying capacity; hypoxia, and therefore unconsciousness, may result. This happens with little or no warning.[10-12] Hypoxia is aggravated during ascent because the expansion of gas (Boyle's law) in the diver's lungs reduces

the partial pressure of oxygen and increases the likelihood of hypoxic unconsciousness. Hyperventilation is a hazardous diving technique and should be discouraged.

Overall, two obvious problems emerged. Firstly, many victims were overseas tourists, often travelling alone and often not able to speak English. This would have made snorkelling more hazardous, as such tourists are unlikely to understand the documentation supplied by many commercial operators, or unable to follow instructions from snorkelling supervisors. Secondly, buddy diving — in which people dive in pairs, each responsible for the other's safety, and a requirement for prompt rescue — was infrequent.

The 90 Australian snorkelling deaths in the 1972–1987 study by Walker[1] were not as fully documented as those in our study, and not all were investigated by coroners, resulting in more conjecture about the causes of death, as well as documented trauma and marine animal injury. Nonetheless, some comparisons are possible. The average age of those who died had inceased from 30 years in Walker's study to 45 years in ours; the proportion of females had increased from two of 90 (2%) to 15 of 60 (25%), mostly in the drowning group; and spearfishing deaths had reduced from 66 of 90 (73%) to 15 of 60 (25%), with most snorkellers being recreational swimmers engaged in organised boat operations. Cardiac deaths had increased from three of 90 (3%) in Walker's study to 18 of 60 (30%) in ours, while the incidence of hypoxia from hyperventilation and/or ascent causing unconsciousness and drowning had changed little (16 of 90 [18%][1] to 12 of 60 [20%]).

We do not suggest that we examined all Australian snorkelling deaths during the period of our study. Some diving deaths are never recorded in medical databases or investigated by State coroners. Our cases are therefore a biased sample and may underestimate the overall problem. Further, many victims were overseas tourists, and this would not have been conducive to the recording of pertinent information, either of the victim's past or the circumstances leading to the accident. Nonetheless, safety measures to reduce snorkelling fatalities may be extrapolated from this information. These include requiring prospective snorkellers to complete a questionnaire indicating their level of aquatic skill and physical and medical fitness, making the use of flippers for propulsion and the use of the buddy system mandatory in commercial recreational snorkelling, and strongly discouraging the dangerous practice of hyperventilation in breath-hold diving.

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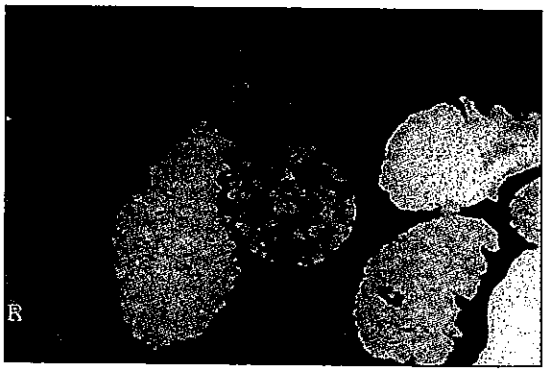
Snapshots!

Have a nice day!



Computed tomography scan of a liver, showing several cholesterol calculi floating in the gallbladder lumen.

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The Panda

A 26-year-old Chinese woman presented with sudden onset of severe headache. A cerebral scan, performed to look for subarachnoid blood, demonstrated a mass, and an MRI of the brain was performed. We soon had our sights on the problem, as before us appeared an unexpected vision — a panda! Further analysis revealed the head to be a primitive neuroectodermal tumour, with the ventricles appearing as ears and legs.

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