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Scuba diving while taking an antidepressant: A case report of a diver with depression

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Abstract

Divers have sought in the oceans food and valuables for centuries. More recently, scuba diving became associated with the military. In the 1950s, scuba diving evolved into a recreational sport for pleasure and leisure. It was greatly popularized after the invention of the "Aqua-Lung" made famous by oceanic explorers like Jacques Cousteau. A wide network of aficionados developed upon the evolution and dissemination of diving technology and the founding of PADI: "The Way the World Learns to Dive." However, an important safety issue often ignored concerns the evaluation of the risk-to benefit ratio for divers suffering from mental illnesses such as major depression or panic disorder. The prescription of psychoactive medications such as antidepressants or anti-anxiety drugs for scuba divers likewise merits caution. This case report and brief review highlight important considerations for counselling divers and the general public on safety as regards to psychiatric diagnosis and medications during scuba.

Keywords: Major depression; Panic disorder; Suicide; Psychosis; Cerebral metabolism; Trimix.

Abbreviations: TCA: Tricyclic Antidepressant; MAOI: Monoamine Oxidase Inhibitor; SSRI: Selective Serotonin Reuptake Inhibitor; HPNS: High-Pressure Neurological Syndrome; FSW: Feet Of Standing Sea Water; DCS: Decompression Sickness; ATA: Atmosphere Absolute; MTNR: Melatonin Receptor; CPAP: Continuous Positive Airway Pressure; NOAA: National Oceanic And Atmospheric Administration; DMO: Diving Medical Officer; OSA: Obstructive Sleep Apnea.

Introduction

Humans have dived in the oceans for food, pearls, and sponges for centuries. However, only recently has diving become popular with the invention of the self contained underwater breathing apparatus. Humans have also suffered from major depression and melancholia since antiquity. Only in the last century have effective medications become available to treat depression. The safety of divers with depression and other psychiatric disorders and in those taking psychotropic medications such as anti depressants has become a recent concern.

Having clinical or major depression, let alone taking medications to treat it, was until recently a strict contraindication to diving. Furthermore, the issue of antidepressants and depression was largely ignored in published guidance for working divers [1,2]. Governmental organizations often screened out recruits for military diving who had a history of depression [3]. However, many practicing psychiatrists have come to realize that many recreational divers suffer from depression and concomitantly take antidepressants. This fact prompts a review of the safety issues in this setting.

A conservative estimate of the number of recreational divers in the U.S. is 1.2 million ± 15% [4]. According to a survey of 3,000 randomly selected members of the Divers Alert Network (DAN), 4.8% of 1,654 respondents (or ~1% of the membership who dive recreationally) reported using antidepressants to treat depression [5]. Taking into account those who dive five or more times per year (about 1.2 million), the number of divers taking antidepressants for depression approximates 57,600--a large group that should at least theoretically seek a medical release before diving.

A review of the medical literature indicates a relative paucity of content regarding antidepressant use in the diver population [2,6,7] (Tables 1 and 2). It does provide some guidelines generally obvious to most clinicians about psychiatric disorders and symptoms increasing the risk of scuba diving. However, we found no systematic blinded trials of antidepressants in divers.

The non-medical dive literature has identified various aspects of diving and mental health symptoms and/or treatments that fit together topically. These topics include psychiatric disorders and comorbid conditions relevant to the diver; overlap between Decompression Illness (DCI) and mental health symptoms; psychotropic drug use in divers including anxiolytics, stimulants, antidepressants, antipsychotic agents, and substances of abuse; professional and industrial standards for antidepressant and other psychotropic drug use (including environments other than the sea; e.g., hypobaric and hyperbaric); and anecdotal/expert advice on the use of antidepressants and other psychotropics in the diving population.

These sources were retrieved via searches in the following sources: PubMed [8]; Psychological Abstracts [9]; Rubicon Research Repository (which includes the Journal of Hyperbaric Medicine and Undersea and Hyperbaric Medicine Journal) [10]; Naval Research Laboratory Ruth H. Hooker Research Library [11]; Divers Alert Network [12]; Civil Aerospace Medical Institute Library [13]; and the Defense Technical Information Center [14]. Unfortunately, many references often lack detailed citations in support of their claims. Nevertheless, this literature provides some interesting preliminary facts, which are further discussed subsequently.

Table 1: Prescribed antidepressants in divers.

Source	Medication	Indication	Side effects	Adverse impact on Diving
Scuba Diving Magazine	Fluoxetine	Depression possibly moderate to severe	None	No
Scuba Diving Magazine	TCA	Recurrent Depression w/ Panic Disorder	Tachycardla, dry mouth, jitteriness	Unclear
Scuba Diving Magazine	SSRI	Recurrent Depression w/ Panic Disorder	Dry mouth	No
Live Expert Panel*	Prothiaden (Dosulepin)	Hyperhidrosis	Not reported	Unclear
Psychiatrist Diver**	TCAs/SSRIs	Anxiety/ Panic	Congruent with each class	No

Table 2: Related research.

Type	Subjects	Medication	Results
Dry Hyperbaric	Animal	Lithium	Potentiated HPNS in rats
Normobaric & Dry Hperbaric	Human	TCA	Physical activity, hyperthermia, hyperbaric 02, all increased serum levels
Dry Hyperbaric	MAOI	Animal	Decreased judgment & muscle coordination at 50 FSW
Normobaric	Human	Citalopram	Performance: No impact on psychomotor; impairment of vigilance
Normobaric	Human	Escitalopram	No Impact on psychomotor performance or driving
Normobaric	Human	Mirtazapine	Impaired driving performance
Normobaric	Human	Sertraline	No impairment of vigilance performance

Medical and major psychiatric disorders and diving

Divers often conceal medical and psychiatric conditions from diver operators. Approximately 11% of 1,350 respondents were not truthful about preexisting medical conditions before their dive. These problems include the following: cold/flu, 27%; asthma: 22%; allergies/sinus problems, 8%; hypertension, 6%; ear infection, 5%; back injury, 4% mental illness, 4%; other, 24% [15].

Major psychiatric disorders and their symptoms can directly affect diver safety. There are no epidemiological studies of the causes of diving accidents. The presence of suicidal ideation regardless of diagnosis is generally considered an absolute contraindication. Although often difficult to prove, there have been many diving accidents under the suspicion of suicide. Active psychosis would also be considered an absolute contraindication given impairment in reality testing and judgment. In mood and anxiety disorders, the cognitive dysfunction, global slowing, impaired concentration and judgment arising from many psychiatric disorders and substances of abuse can make scuba particularly dangerous. For example, the onset of a panic attack during a 5 deep sea dive is potentially life-threatening. Physiological changes during diving (e.g., pH, lactate, etc.) can themselves precipitate a panic attack even in healthy subjects. Under duress during panic, a diver may disregard well-known and rehearsed safety procedures. There are also abrupt changes in arterial gases and in gas consumption during an attack. Given the high comorbidity between Obstructive Sleep Apnea (OSA) and depression, there are concerns about altered levels of blood carbon dioxide, arrhythmias, and impaired alertness. Disregarding these risks is potentially dangerous and a consultation with a physician is recommended to fully understand the implications of a dive.

Prescribed psychotropic drug use in divers

Various reports provide examples of psychotropic use in divers. In terms of depression and the use of antidepressants, Scuba Diving Magazine published two individuals diving successfully while on antidepressants [20]. The first used fluoxetine and had no side effects while diving. The second individual successfully titrated from a Tricyclic Antidepressant (TCA) to a Selective Serotonin Reuptake Inhibitor (SSRI). Also, as mentioned above,

a survey of recreational divers revealed 4.8% of them dived while using antidepressants to treat depression. The only other reports of psychotropic use in divers includes mention of TCA use by divers at a live panel discussion (not necessarily specific for depression), as well as the effects of lithium on High Pressure Nervous Syndrome (HPNS) [21]. HPNS is a neuropsychiatric disorder that can occur in depths beyond 100 meters while breathing a helium-oxygen mixture [22]. Regarding lithium, lithium potentiated HPNS in rats but prevented the nitrogen-narcosis-induced loss of righting response [23]. It is hypothesized SSRIs may contribute to serotonin levels potentiating HPNS, due the similarities between serotonin syndrome and HPNS [22,24].

For obvious reasons, another area of psychiatric interest besides depression in divers includes anxiety/panic. One researcher, a prolific diver and psychiatrist with a special interest in this area, has successfully used TCAs and SSRIs in many of his patients who dive [7,25]. His review of the literature also confirms no published research on antidepressants in the 2-5 ATA pressure range, and he reported no test data on antidepressants from drug companies in diver populations [26].

Hypnotics are a major class of medications prescribed to psychiatric patients and should not be dismissed in the context of diving. The older agents with longer half-lives like many benzodiazepines can cause sedation and motor 66 impairments the following day. Newer non-benzodiazepine agents with shorter half-lives such as zolpidem and eszopiclon may be safer in terms of impaired alertness the following day. However, the FDA recommended in 2013 lowering zolpidem dosages because of residual impairment in alertness the following day that could be dangerous during driving or diving. Whether melatonin receptor agonists (MTNR1, MTNR2; e.g., ramleteon) or orexin receptor antagonists (e.g., suvorexant) offer any benefits in this setting remains unstudied.

Professional and industrial standards

Professional and industrial standards for antidepressant and other psychotropic drug use (including environments other than the sea; e.g., hypobaric and hyperbaric) are more strict given the more extreme environment and consequences. Much of what is found in the literature revolves around industry standards and/or guidance which include standards for fitness for duty regarding the diagnosis of depression, and separately the potential safety issue of being on a psychotropic such as an antidepressant. Clearly, suicidal ideation is a contraindication to diving as there have been many accidents with a high suspicion of suicidal behavior. A chapter in a medicine textbook suggests: "[as] a general rule, patients requiring psychotropic medications should be disqualified, although sport divers have been diving while using [SSRIs] with no apparent problems" [1]. Within the Navy there are two schools of thought: 1) diving supervisor making a decision regarding medication and fitness for duty based upon the Diving Medical Officer's (DMO) recommendation, and 2) DMO's belief that under no circumstances should a diver ever take any kind of drug within 24 hours of diving [27]. Commercial standards are more stringent than recreational standards. For example, NOAA's medical standards list mood disorders as disqualifying conditions when treatment is required beyond 6 months [28]. Finally, in a medical questionnaire for scuba diver training applicants, under the physical exam guidelines for "instructions to the Physician," the use of psychotropic medications under behavioral health is listed as a "relative risk condition" [29].

A physician trained by NOAA in dive medicine, and certified as a PADI instructor, reports a medication such as citalopram is not contraindicated for recreational diving as long as the condition is stable, and the patient has been on it for 90 days or more without major side effects [30].

Other standards in the industry center around the potential side effects of antidepressants on diving safety, and some of these standards are similar in nature to other high-risk environments, such as aviation [31]. This article recommended the possibility of using these medications as maintenance for depression in Canadian aircrew in non-tactical flying personnel after full resolution of depressive symptoms.

Another article on healthy subjects found no impairment in driving performance or psychomotor performance using escitalopram, but did find driving performance significantly impaired using mirtazapine [34]. Yet another study found time and dose dependent impairment of vigilance performance with citalopram but not sertraline [35]. Clearly, the neurocognitive effects of antidepressants to treat depression, even in those who do not dive, merit further study.

Case report

The patient, a 37 year-old Caucasian male U.S. Navy veteran, had recurrent Major Depressive Disorder (MDD) and secondary panic disorder. The past medical history included gastroesophageal reflux disease, obesity (BMI 36.8), hypertension, chronic sinusitis, obstructive sleep apnea, and internal hemorrhoids. The patient denied smoking, using recreational substances, drinking caffeinated beverages, or using alcohol to excess. His career as a Second-Class Navy Diver began at age 19 years. He completed six naval missions. After discharge, he completed both the Instructor Certification and Trimix (a combination of oxygen, helium, and nitrogen used in deep diving) Certification. His deepest dive was 334 feet using a mixture of 65% helium, 11% oxygen, and 24% nitrogen with a planned narcotic end depth of 100 feet for 12 minutes with routine subsequent ascent stops.

Several medications were used to manage his recurrent MDD (see Table 3 for summary), and these were often discontinued because of the occurrence of known side effects (e.g., nausea, sweating, akathisia, weight gain) unrelated to his diving. Initially, fluoxetine at 20 mg daily helped the depression symptoms, but he noted dry nasal mucosa making equalizing sinus pressures more difficult during his then deepest dive of 165 feet. He subsequently took paroxetine titrated to 40 mg daily and was able to dive several times to depths of around 200 feet without incident. However, it caused akathisia and was switched to bupropion SA, which after titration to 200 mg twice a day, main-

Table 3: Antidepressants Trials by patient

Medication	Side Effect
Fluoxetine	Dryness
Paroxetine	Akathisia
Bupropion SA	None
Liothyronine (Added to bupropion)	Tremor, Chest pain, palpitations, nausrea
Lithium (added to bupropion)	sensation of tremor
Mirtazapine	Increased appetite, 45 lb weight gain
Escitalopram	Tremor
Nefazodone	None
(Zolpidem, concomitant to treatment)	None

tained remission and allowed diving as an instructor to depths of 18 feet and completing his Trimix Certification.

The patient had a recurrence of another major depressive episode the following year just 1-2 months before an international scuba diving trip. Liothyr onine (25-50 micrograms daily) was added to his regimen, but it did not help depression symptoms. While taking it he reported the onset of tremor, chest pain, palpitations, and nausea. Cardiac evaluation was negative. Liothyronine was discontinued, and a lithium boost (300 mg twice daily) was initiated. He took the lithium and bupropion while on the 8 international dive trip and reported a sensation of tremulousness without an observable tremor diving to a depth of 110 feet. He did not achieve full resolution of depression symptoms on this combination so was switched to mirtazapine. Although mirtazapine induced a full remission of symptoms, the patient reported increased appetite with a 45 lb (18 kg) weight gain. Nevertheless, mirtazapine caused no overt difficulties when diving to a depth of 150 feet. He was then switched to escitalopram, but this was also discontinued following the onset of a tremor. Venlafaxine was deferred because of hypertension. He was subsequently treated with nefazodone due to concerns about erectile dysfunction.

Of note, the patient took zolpidem 10 mg at bedtime to treat the depression related insomnia during most of his course. He used CPAP nightly. He was cautioned about the potential for zolpidem to impair performance and to have residual effects on the morning after taking a dose.

Subsequently, the patient changed providers. He was lost to further follow-up.

Discussion

This case highlights the paucity of medical literature in the population of sea divers. There is much anecdotal evidence regarding antidepressant use in recreational diving, and this case provides a detailed example. Unfortunately, little data concerning risks were available. As is typical of patients who dive and seek medical attention for depression, the patient did a "ground trial" of his medications prior to diving. In this case, it became almost expected he would develop side effects; however, these never impacted his ability to dive nor did diving exacerbate his side effects. In only one case, while on fluoxetine, did a side effect make it more challenging to dive because of mucosal dryness impairing his ability to equalize ear pressure.

A limitation of this case presentation includes a focus on recreational diving, because there are no published case reports of commercial divers taking antidepressants-nor would any necessarily be expected given the strict standards for commercial and military diving. As such, it remains unclear under those circumstances, i.e., when the risk of missions is higher or when performance expectations are elevated, how an SSRI such as escitalopram would affect the diving operator. This is important to mention considering the evolving situation when pressure changes and high performance are expected such as in the military environment. As a corollary, for example, Canadian regulations permit non-combat (or non-fighter jet) pilots with controlled depression to fly while taking citalopram. The US Air Force also permits non pilot aircrew such as loadmasters to take citalopram, with a waiver granted under similar circumstances (clear diagnosis with well-controlled symptoms and no impairments in duties) [36].

Another limitation of this case is the recall bias inherent in determining memory of specific side effects and especially the time course of a "ground trial" to test the escitalopram prior to his deepest dive. To help mitigate recall bias of side effects, his outpatient medical record was reviewed carefully. However, this does not preclude recall bias of potentially worsening symptoms or side effects while diving especially for the early antidepressant trials. Because the patient never stopped a medication or changed medications because of impact upon his diving, the antidepressant medications did not likely have a major influence on his physical or mental ability to dive.

Given the nature of brain receptor changes in anyone on such medications as escitalopram, a minimal recommendation of medication trial above water should be at least 14 days in duration. While full effects, both in terms of symptom control as well as 1010 side effects, would take much longer to establish (4-6 weeks), 14 days would at least allow for assessment of immediate side effects potentially affecting dive ability. Medications such as fluoxetine with long half-lives may require a longer interval as the drug concentration can build over weeks. The recommendation assumes the individual is asymptomatic or their depression is of a mild degree without impact upon their or another individual's safety or fitness to dive (e.g., cognitive effects of depression affecting concentration or decision-making). This included diving to depths of 334 feet with Trimix gases. Given the fact that the patient suffered from side effects from every antidepressant he tried, it is noteworthy that in only one case did any side effect (dry mouth) affect his diving habits in any way. At one point in time, even for recreational diving, taking antidepressants would have been considered a strict contraindication. However, more recently one could argue pending further research the potential effects of SSRIs themselves (aside from the diagnosis of depression) should not constitute a contraindication to diving.

Conclusion

This case supports the cautious use of SSRIs in recreational divers under treatment for mild to moderate depression. It highlights a diver suffering from depression with secondary panic who dives safely while on antidepressants. He had numerous trials of psychotropics, most of them with intolerable side effects unrelated to diving. The notable exception is fluoxetine, which led to xerotic Eustachian tubes. This made it more challenging, but not impossible, to equalize sinus pressures. This case report also highlights the possible safety of diving while on lithium, or at least the combination of lithium and bupropion. However, the potential for encountering dehydration and electrolyte imbalance while diving may elevate lithium to toxic levels, making it a prohibitive prescription. In fact, this individual sensed an unobservable tremor at 150 FSW, which would be of concern if it had adversely influenced fine motor skills involving dive equipment.

We hope this case report will assist mental health providers in understanding it is possible for a diver to safely dive while under medication treatment. It is imperative to have a baseline understanding of the nature of the diving activities as well to assess for suicide risk, presence of psychomotor retardation, or cognitive impairments that would preclude safe diving, and of course to monitor side effects closely.

Given the nature of brain receptor changes, a minimal predive medication trial should be at least 14 days in duration. While full effects would take much longer to establish (4-6 weeks), 14 days would at least allow for assessment of immedi-

ate side effects potentially limiting the ability to dive. Medications such as fluoxetine with long half-lives may require a longer predive trial. Other considerations include past medication sensitivity and potential for low p450 activity. Fourteen days would conservatively allow most medications to reach five half-lives. Also, the pre-dive trial assumes an asymptomatic patient or one with mild depression that does not impact his or her, or another diver's, safety to dive (e.g., cognitive effects of depression affecting concentration or decision-making).

Many practitioners would reasonably hesitate to prescribe antidepressants to recreational divers. However, the literature, albeit very limited, along with this case, suggests that antidepressant medication for depression are not an absolute contraindication for recreational divers, when taken as prescribed along with the supervision of a physician. A greater potential issue, though more nuanced to adjudicate, concerns the severity of depression, whether left untreated because of diving risks or even if treated. Major depression is associated with a panoply of cognitive deficits that can potentially impact the diver irrespective of medications [37]. In such cases, clinicians should consult experts in mental health of scuba divers. Regardless, further research is needed to better assess risks of major depression and the use of antidepressant medications in divers.

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