L 1
Treatment of mass exposure to hydrogen sulfide poisoning utilizing hyperbaric oxygen therapy
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Introduction / Background: Hydrogen sulfide (H2S) is a toxic gas produced via breakdown of organic matter. Hydrogen sulfide exposure can cause symptoms ranging in severity from mild (dizziness, headache, nausea) to severe lactic acidosis, respiratory failure, pulmonary edema, cardiac arrhythmias and death. Treatment modalities include oral countermeasures and 100% FiO2 with supportive therapy. However, case studies utilizing hyperbaric oxygen therapy have been reported with general benefit seen in severe cases of toxicity.

Materials and Methods: In this report, cases of mild to moderate hydrogen sulfide toxicity occurred aboard USN ship, resulting in a mass casualty of >30 patients. Patient symptoms ranged from dizziness, headaches, nausea, vomiting and one patient with altered mental status. Most patients' symptoms resolved after several hours of supportive therapy but six patients had symptoms refractory to 100% FiO2 at 1 atm. These six patients received HBO2 therapy with a USN Treatment Table 9 after consultation with the local emergency room and hyperbaric assets.

Results: Four separate chambers were utilized, including two chambers onboard USN ships and the local explosive ordinance disposal (EOD) chamber. Complete resolution of symptoms in all six patients was achieved within the first breathing period. Patients were monitored after treatment aboard USN ship medical department. No patients required emergency room care.

Summary / Conclusion: These cases demonstrate an expanded use of HBO2 to include moderate cases of H2S toxicity refractory to first-line therapy.

L 2
Sudden immersion pulmonary edema - case report: multifactorial etiology and approach to comprehensive diagnostic workup and treatment
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Introduction / Background: Hypertension is cited as a risk for sudden immersion pulmonary edema (SIPE), without further discernment. We report a 69-year-old female diver with a 46-year history of hypertension and more than 1,000 dives who developed SIPE while fighting a current two weeks after metoprolol was substituted for atenolol in her medication regimen.

Materials and Methods: Workup diagnosed primary hyperaldosteronism, responsive to spironolactone. Thirty subsequent dives in calm conditions were asymptomatic. On the next dive, fighting a current resulted in a milder episode of SIPE. Subsequent work up included stress echocardiogram (ECHO), heart catheterization, pharmacogenomic testing and immersion with vigorous exercise blood pressures (BP) measured before and after 40 mg sildenafil.

Results: Stress ECHO at 10 METS showed BP rise to 220/120. Subsequent exercise at 10 METS after starting benazepril showed no significant rise in BP. Heart catheterization was normal, except pulmonary artery pressure increased from 14 mmHg to 21 mmHg after an 800-mL bolus of normal saline. Pharmacogenomic testing showed the diver was a "slow metabolizer" of metoprolol. BP after immersion in scuba gear and vigorous finning went from 91/59 to 140/90 in six minutes. After 40 mg of sildenafil and 90 minutes rest, BP after immersion in scuba gear and vigorous finning only increased to 114/74.

Continuing daily spironolactone and benazepril, 15 subsequent scuba dives were uneventful after taking 40 mg of sildenafil before diving.
Summary / Conclusion: It is not sufficient to find and treat hypertension at rest in divers who have had a SIPE episode. Workup should include testing for extreme hypertension with exercise similar to fighting a strong current and immersion hypertension with and without exercise. Early onset hypertension resistant to three or more medications should be investigated for primary hyperaldosteronism. In addition, pharmacogenomic testing may be recommended if an adverse drug event is suspected.

Case report of BCG cystitis treated with hyperbaric oxygen
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Introduction / Background: Hyperbaric oxygen (HBO2) therapy is a UHMS- approved treatment for radiation cystitis and has been used for other causes of cystitis such as cytoxan-induced hemorrhagic cystitis and interstitial cystitis, among others. Immunotherapy with bacillus Calmette-Guérin (BCG) is the most effective treatment of non-muscle invasive bladder cancer. BCG acts as a non-specific stimulant of the reticuloendothelial system, causing a local inflammatory response. BCG attaches to bladder tumor cells which then stimulates an immune response involving a multitude of cytokines and local migration of polymorphonuclear cells leading to death of the cancer cells. The typical protocol of a single six-week course has been shown to provide long-term protection from tumor recurrence and reduce disease progression. Serious side effects are uncommon. A case is presented of severe BCG-induced cystitis treated with HBO2 therapy.

Materials and Methods: A 51-year-old man with left ureteral transitional cell cancer and non-muscle invasive bladder cancer-in-situ was treated surgically with nephrectomy and ureterectomy, followed by intravesicular BCG. After the fifth treatment he developed severe bladder pain and spasms, dysuria, hematuria, urinary frequency up to 50-60 times per day, and nocturia eight to 12 times per night. He was treated with oxycodone (4 per day), Vesicare, Detrol, and Colace without benefit. Urine cultures twice were negative. Cystoscopy showed multiple red velvety areas. Biopsy showed chronic inflammation. He was referred for HBO2 therapy.

Results: He received 60 HBO2 treatments at 2.2-2.4 ATA for 90 minutes of oxygen time. At the end of treatment he reported that his symptoms had improved with substantial improvement in his quality of life: urinary frequency reduced to 10-12 times per day, nocturia to two times per night, oxycodone use to 0-1 per day, and no hematuria. Repeat cystoscopy showed minimal erythema.

Summary / Conclusion: BCG cystitis may be considered for HBO2 therapy if other standard therapy has failed.

The treatment of perioperative spinal cord injury with hyperbaric oxygen therapy: a case report
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Introduction / Background: To describe a potential novel application of hyperbaric (HBO2) oxygen therapy in the successful treatment of a postoperative spinal cord injury. A 68-year-old man presented with an acute spinal cord injury (American Spinal Injury Association/ASIA impairment scale D), on the background of degenerative lower thoracic and lumbar canal stenosis. He underwent emergent decompression and instrumented fusion (T9 to L5), with an uncomplicated intraoperative course and no electrophysiological changes. Immediate post-operative assessment demonstrated profound bilateral limb weakness (1/5 on the Medical Research Council [MRC] grading scale, ASIA impairment scale B), without radiological abnormality.

Materials and Methods: Conventional medical management (hypertension, level 2 care) was instigated with the addition of riluzole, with no effect after 30 hours. At 36 hours HBO2 therapy was started at 2.8 ATA/90 minutes, and repeated after eight hours, with a further three treatments at 2.4 ATA/90 minutes over 48 hours. HBO2 was well tolerated and safely applied to this perioperative spine surgery patient.
Results: The patient demonstrated near-immediate improvement in lower limb function to anti-gravity (MRC grading 3/5) after one treatment (Table 1)

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<td>knee extension</td>
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<td>ankle dorsiflexion</td>
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<td>ankle plantar flexion</td>
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<td>dorsiflexion toe-EHL</td>
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Motor improvement continued over the following treatments (Table 2),

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<td>dorsiflexion toe-EHL</td>
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and after two weeks the patient was ambulatory, with an overall significant time to neurological recovery compared to previously reported duration of recovery from post-operative spinal cord injury. At four months, the patient demonstrated normal motor function with no sphincteric disturbance.

Summary / Conclusion: The application of HBO2 contributed to the immediate and sustained improvement (ASIA B to ASIA E) in motor recovery after post-operative spinal cord injury. HBO2 therapy may represent a new avenue of therapy for spinal cord injury and requires further prospective investigation.

L 5

High-altitude high-opening parachuter with decompression illness? A case report
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Introduction / Background: It is well known that aviation-associated hypobaric exposures place military operators at risk for decompression illness (DCI). While DCI is well documented in high-altitude pilots, only a few cases have been reported in high-altitude parachuters. We discuss a case of DCI in a high-altitude high-opening (HAHO) parachuter successfully treated with HBO2 therapy.

Materials and Methods: A 36-year-old male special forces HAHO parachuter with a remote history of non-Hodgkin’s lymphoma of the mediastinum presented with concerns for DCI after a training HAHO jump from 25,000 feet. Jump course included prebreathing 100% oxygen during ascent and jump phases. Patient reported loss of consciousness during descent while at approximately 15,000 feet; he regained consciousness at 6,000 feet, at which point he used significant exertion to maneuver to the landing zone. Upon landing, he had another brief syncopal episode associated with perioral cyanosis followed by development of severe left-sided chest pain, fatigue, and confusion. He was transported to UCSD ER, where he was alert and oriented, with stable vital signs. On exam he had right pronator drift, right end-gaze nystagmus, and severe non-reproducible left chest wall pain with no external evidence of trauma. CT imaging of the chest, head, and neck were negative for traumatic injury or signs of stroke.
Results: A U.S. Navy Treatment Table 6 was initiated, and the patient’s symptoms resolved fully. Subsequent ECHO revealed no PFO or intrapulmonary shunting.

Summary / Conclusion:
We report a case of DCI in an experienced HAHO parachuter following a syncopal episode at altitude. This was a low risk exposure profile and we theorize that his syncopal episode may have been an inciting event for developing DCI.

L 6
Hyperbaric oxygen and turn of course in treatment-refractory multiple brain abscesses caused by *Fusobacterium necrophorum*
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Introduction / Background: Brain abscesses are rare, incidence 0.3-0.4/100,000, with a mortality around 15%, neurological sequelae in 30%. Brain abscesses caused by *Fusobacterium necrophorum* are extremely rare (described in association with Lemierre’s syndrome). We present a case with a 16-year-old boy with refractory brain abscesses, suffering from severe pain and deteriorating neurological condition who had a remarkably fast recovery only three days after initiation of hyperbaric oxygen (HBO2) treatment.

Materials and Methods: Conventional treatment: He presented with neck pain to the GP and was sent home with paracetamol. Next day he was admitted via ER with severe neck pain and Horner’s syndrome on the right eye. Computer tomography showed widespread abscesses in the right side of the neck, occluded carotid artery and multiple brain abscesses. He had emergency surgery of the neck, started on meropenem/metronidazole followed by multiple revisions of the neck over the following days. Blood cultures were positive for *F. necrophorum*. Two consultations by neurosurgeons recommended HBO2 therapy but the patient was not referred until day 17. By then the patient had deteriorated to Glasgow Coma Score 11-12, left hemiparesis, severe pain (50mg oxycodone, 17.4mg methadone, 300µg clonidine daily) and a midline shift on MRI.

Results: Treatment was started immediately on referral, GCS increased to 14-15 after first treatment, with complete remission of the hemiparesis after three treatments; all opioids were weaned after 10; and he was discharged to an outpatient clinic after 15. He received 40 HBO2 treatments in total. He returned to school two months after presentation. MRI at seven months showed complete remission of abscesses but a persistently occluded carotid artery and collateral flow to the right hemisphere. Antibiotic treatment was stopped. Neuropsychological assessment was normal.

Summary / Conclusion: The remarkable recovery coincided with the start of HBO2 therapy. There are publications that support HBO2 in cerebral abscesses, but the validated evidence is still weak. Randomized controlled studies are warranted.

L 7
Undifferentiated retinal ischemia in a patient with extensive vascular malformations and encephalocele treated safely with combination NBO2 and HBO2
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Introduction / Background: A male in his early 70s underwent complicated retinal detachment repair in his right eye. Upon waking from MAC anesthesia, he had no light perception and no pupillary response in his left (non-surgical) eye, which had baseline 20/25 vision. Early ophthalmologic exam was inconclusive. Central retinal artery occlusion (CRAO) and cerebrovascular accident (CVA) were considered. Initial ED workup included stroke code activation, neurology consultation and emergent CT/CTA head and neck imaging. This revealed extensive arteriovenous malformations (AVM) throughout the brain and suspected lymphovenous malformations in the left periorbital area. Imaging was negative for acute hemorrhage, infarct or large vessel occlusion. A 2-centimeter encephalocele was incidentally found protruding through a cribriform plate defect, invading the left ethmoid sinuses.

Materials and Methods: CVA and CRAO remained on the differential, but his examination showed no other focal neurologic deficits consistent with CVA, and his fundoscopic examination by ophthalmology did not reveal definitive pathologic findings. Over the next
60 minutes, his vision improved to 20/200 while on high-flow O2. Rapid MRI and MRA imaging did not show evidence of acute CVA, making acute retinal ischemia the most likely etiology. The risks of HBO2 treatment were felt increased but acceptable given his vascular malformations and encephalocele.

**Results:** The patient ultimately deferred HBO2 until after an overnight trial of high-flow O2. His vision did return to near baseline after 12 hours, but repeatedly declined when O2 was removed. He was treated with myringotomies to avoid straining/Valsalva for modified 2 ATA for two-hour tables x2 (slowed 1 fsw/minute decompression and air breaks inserted), with hour on/hour off NBO2 in between.

**Summary / Conclusion:** Acuity stabilized at 20/40 after treatments. The patient was observed off oxygen for the next 24 hours and was discharged against medical advice at his request. Follow-up with ophthalmology, neurology, neurosurgery, and otolaryngology is being arranged. He had no complications from HBO2.

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**Hemorrhagic stroke while cave diving in remote Western Australia: A case report**

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Submitting Author: Peter Buzzacott, PhD

**Introduction / Background:** Western Australia (WA) covers more 2.5 million square kilometers, with ~500,000 people residing outside of Perth, the state capital. Cave diving is conducted in WA in the eastern "Nullarbor" desert region, more than 1,000 kms from Perth.

**Materials and Methods:** An experienced male technical diver (54 years old) undertaking an advanced cave diving course behaved unpredictably underwater while at ~150 meters into a flooded passage ~100 meters below ground. Suspecting a stroke, his companions guided the diver back to the exit lake, holding the regulator in his mouth and steering him. The dive equipment was removed and the diver was assisted out of the water.

**Results:** He complained of headache and cold. On examination, his speech was slurred and his movements uncoordinated, but he displayed no localizing or clearly diagnostic signs. Oxygen was brought from the camp above. Divers Alert Network advised to give candy and Gatorade® to exclude hypoglycemia. The patient was awakened for medical evaluation every 15 minutes while the team prepared for extraction over steep loose rock with, finally, an 8-meter vertical pitch. The patient was ambulant (albeit heavily aided). Meanwhile, the Royal Flying Doctor Service (RFDS) mobilized. By the time the party reached the surface air temperature was falling and sunlight was waning. An airstrip for night landing was located at the closest town, 430 km away and ground transport was then hindered by hundreds of kangaroos occupying the road for warmth.

**Summary / Conclusion:** The patient was transferred to RFDS at 2.30 a.m. and the fixed-wing plane flew 190 km to Kalgoorlie to refuel. A preliminary computed tomography (CT) scan at the local hospital preceded flying the patient on to Perth, where CT and magnetic resonance revealed brain stem hemorrhage. Two surgical evacuations and placement of a ventriculoperitoneal shunt were undertaken. Mild residual dyspraxia remains but the patient has returned to recreational diving.

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**Hyperbaric oxygen as successful monotherapy for a severe ulcerative colitis flare**

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Submitting Author: Nicole Harlan, MD

**Introduction / Background:** We present the case of a 33-year-old man with a history of severe ulcerative colitis (UC) who was treated with hyperbaric oxygen (HBO2) therapy as the monotherapy for a flare of his disease. Hypoxia and the hypoxia signaling pathways play a role in the pathogenesis of inflammatory bowel disease (IBD), causing inflammation and disruption of the microbiome. HBO2 therapy reduces hypoxia in the bowel and some studies suggest that it may be useful in the treatment of IBD.
Materials and Methods: The patient is a 33-year-old man with a history of ulcerative colitis since age 25 who presented with a fevers, abdominal cramping, and bloody diarrhea. One week prior to admission, he began having eight bloody bowel movements a day. His C-reactive protein (CRP) on admission was 146.3. His prior treatments for UC included adalimumab and infliximab, both of which resulted in anaphylaxis. He had received vedolizumab two months prior with some improvement, but due to the development of shingles and pyoderma gangrenosum, his gastroenterologists did not want to treat his current flare with further immunosuppression or steroids.

Results: He was treated with 30 hyperbaric oxygen treatments at 2.4 ATA for 90 minutes over the course of a month and a half. The patient had an improvement in his stool frequency as well as a decrease in the number of bloody bowel movements. His CRP one month after the treatment was 18.4. Additionally, he had improvement in his pyoderma gangrenosum with treatment.

Summary / Conclusion: This case presents more evidence that hyperbaric oxygen therapy is beneficial in the treatment of acute IBD flares. For severe disease or patients unable to tolerate steroids and other immunomodulatory medications, HBO2 is safe and may improve outcomes.

L 10
Successful treatment of radiation-induced colitis and enteritis with hyperbaric oxygen therapy
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Introduction / Background: Hyperbaric oxygen (HBO2) therapy has been extensively studied and frequently applied in the setting of delayed radiation soft tissue injuries. Radiation exposure may result in serious injuries to afflicted tissues due to a fibroatrophic effect; a process including vascular alterations, severe fibrosis and cellular depletion.

Materials and Methods: Between 2013 and 2017 three female patients who developed radiation-induced colitis and/or enteritis following ionizing radiation therapy for various cancers were treated with HBO2 at our institution. Their treatment protocols and therapy course will be discussed.

Results: The three patients presented in this case series had significant resolution of their presenting symptoms. Colonoscopy exams following completion HBO2 therapy demonstrated significant improvement of inflammation and granulomatous tissue in all three patients. Furthermore, two of the patients who had required total parenteral nutrition (TPN) prior to HBO2 therapy were able to successfully transition TPN throughout the course of their HBO2 therapy. The findings at our institution are consistent with the findings of a larger 2012 systemic literature review of HBO2 therapy in this setting.

Summary / Conclusion: Commonly, radiation-induced colitis and enteritis treatment is directed toward symptomatic relief, not uncommonly involving surgical resection of the effected tissue. Numerous studies and case reports have shown the benefit of HBO2 therapy in the healing of radionecrotic soft tissues. A 2012 systemic literature review of HBO2 therapy in 199 cases of radiation-induced colitis, enteritis and proctitis demonstrated a complete resolution of findings in 41% of cases, while 86% of cases experienced at least a partial response. Patients in this case series highlight and reaffirm that the use of HBO2 therapy in this setting continues to show positive results, allowing the patient an improved level of functioning and avoidance of other more invasive therapies. It should therefore be routinely considered in the treatment of radiation-induced enteritis or colitis.

L 11
Indoor welding: A rare cause of accidental carbon monoxide poisoning
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Introduction / Background: Welding is an uncommonly reported source of carbon monoxide (CO) intoxication. We present a case of welding-related severe CO intoxication with subsequent delayed neurocognitive sequelae.
Materials and Methods: Case Report: A 32-year-old female welder with a past medical history of dyslexia and attention deficit-hyperactivity disorder (ADHD), developed a headache, photophobia and dysarthria after welding fuel oil lines for four hours while using a propane-powered welding machine in a parking garage. She presented to an emergency department five hours later; a carboxyhemoglobin concentration at that time was 17.3%. She was treated with normobaric oxygen via non-rebreather face mask and was transferred to a tertiary care center where she received three hyperbaric oxygen treatments with compression to 2.4 atmospheres absolute. Two weeks after discharge from the tertiary facility, she developed dizziness, lightheadedness, short-term memory loss, and word-finding difficulties. She was evaluated by a medical toxicologist who recommended neuropsychologic testing; the testing revealed the presence of cognitive deficits. The patient was referred for cognitive rehabilitation; over time, she reported improvement in her symptoms, and she was able to return to work without restrictions four months after her initial injury.

Results: Although not commonly recognized as a potential source of CO, welding can generate the gas through incomplete combustion of fossil fuels. Use of a fuel-powered welding machine in a poorly ventilated space (such as a parking garage) can result in a life-threatening CO intoxication. This patient’s subjective cognitive difficulties were interpreted through objective testing and in the context of her underlying ADHD and dyslexia; reliance on subjective complaints only may result in overestimation of delayed neurocognitive sequelae.

Summary / Conclusion: Physicians should be aware that welding, especially when performed indoors, can result in significant CO exposure. Formal neurocognitive evaluations can be used to clarify the presence and extent of delayed neurocognitive sequelae after CO poisoning.

L 12
Livedo reticularis in a hyperbaric inside attendant
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Introduction / Background: Livedo reticularis (LR) is an appearance caused by deoxygenated blood in the surrounding cutaneous venous plexus and characterized with blue or red discoloration of the skin. It may be secondary to systemic disorders or divide as physiological, primary and idiopathic without any systemic association.

Materials and Methods: This is the evaluation of a hyperbaric inside attendant who had livedo pattern appear on her skin.

Results: A 39-year-old female who tended to patients during HBO2 therapy complained of mottled bluish lesions on extremities during the session. Within a day after the HBO2 session the lesions disappeared without any treatment. The next day she was taken back to the hyperbaric chamber as an inside attendant and she complained about the same lesions on her extremities during the compression phase. Oxygen breathing was initiated to the attendant at 2.4 ATA and continued throughout the session, but the lesions did not disappear.

In evaluation of the attendant after the session the lesions reappeared. Bluish discolorations were visible and disappeared spontaneously once again until the next day. The day after, the attendant was then taken into the hyperbaric chamber to perform diagnostic tests. The lesions occurred with compression at 2.4 ATA and continued after the compression phase ended. The lesions were also checked while the patient was breathing oxygen and appeared unchanged. Arterial blood pressure, heart rate and oxygen saturation were normal. LR was considered as the diagnosis. The lesions did not resolve with warming; also there was no cold exposure in her medical history. There was no specific finding with the exception of the lesions and no abnormality in the laboratory except an increase in antinuclear bodies. When the extremities were elevated, the lesions regressed. Hence the diagnosis of the case was determined as primary LR.

Summary / Conclusion: LR induced in hyperbaric conditions has not been reported before. It is recommended that patients avoid smoking and vasoconstricting medications. LR is not included in HBO2 contraindication but in this case, the attendant appears to have experienced LR induced during treatment. The question we must ask is whether the attendant continues to work.

L 13
Decompression illness after minimally provocative dive profile: a case report
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Introduction / Background: Decompression sickness (DCS) typically presents after a dive that falls outside a no-decompression dive profile although not all cases of DCS occur after provocative dive profiles.

Materials and Methods: We report a case of a 41-year-old physically fit male public safety diver diving scuba on air. Dive profile was a total of two dives. His first dive was to 35 feet of fresh water (ffw) initially for two minutes at which time he became disoriented and returned to surface. He then went back to 35 ffw for 20-25 minutes, with a safety stop for three minutes prior to surfacing. He was at surface for approximately 1-1.5 hours. He then made a dive to 45 ffw for 20-25 minutes and had a one-minute safety stop prior to surfacing. Thirty minutes later upon returning to shore and unloading equipment he developed symptoms of fatigue, nausea, vomiting, a headache, dizziness, and worsening of his baseline tinnitus. Several hours later he developed paresthesias in bilateral hands and in his left arm.

Results: The patient was seen at an outside ED, where he received oxygen with improved but not resolved symptoms. He was transferred to the hyperbaric facility and diagnosed with decompression illness. He was treated with a U.S. Navy Treatment Table 6. During the first oxygen session after 10 minutes at depth his symptoms completely resolved. No extensions or further treatments were indicated. Patient remained symptom-free at 24-hour follow-up. A cerebral arterial gas embolism due to inert gas with a right-to-left shunt was considered. The patient underwent cardiac evaluation with echo bubble study which identified a patent foramen ovale (PFO). We recommended no further diving unless PFO was repaired.

Summary / Conclusion: Patient is a 41-year-old male public safety diver who developed DCI despite a no-decompression dive profile and without breath-holding on ascent that resolved with HBO2. When there are DCI symptoms in the setting of a no-decompression dive profile a workup for PFO should be considered.

L 14

Use of hyperbaric oxygen therapy in the successful treatment of an open hip disarticulation and soft tissue loss secondary to chron's disease with sepsis and intra-abdominal perforation

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Introduction / Background: This case highlights the integration of multiple specialty services in the treatment of a patient with necrotizing fasciitis. A 34-year-old man, without past medical history, presented with sepsis secondary to an intra-abdominal perforation with soft tissue infection of the right lower extremity. The patient was admitted to the trauma surgery team and taken to the operating theater for emergent surgical exploration and debridement, which extended from the right thigh and into the abdomen.

Materials and Methods: He underwent a right hemicolectomy, and left in discontinuity with an open abdomen. He was transferred to the trauma ICU unit. The patient underwent multiple surgical washouts, debridements and revisions, including: right thigh debridement; resection of the sartorius and gracilis muscle bellies; resection of the terminal ileum; anastomoses of the colon; wound vac placement; and abdominal closure. The surgical pathology was returned with a diagnosis of Crohn’s disease. The burn team was consulted for additional washouts, surgical care, and placement of dermal substitute (PriMatrix). The hyperbaric medicine team was consulted to aid in wound healing and to prepare the wounds for surgical skin grafting. Additionally, colorectal surgery and gastroenterology were consulted for treatment and follow-up regarding the patient’s Crohn’s disease. The patient was still at risk of a hip disarticulation secondary to the necrotizing fasciitis.

Results: Control of the infectious component of the patient’s wounds was accomplished, and hyperbaric oxygen therapy was continued through the patient’s multiple surgical procedures. The patient progressed well, with greater than 95% uptake in his grafts. His leg was salvaged, and he is currently ambulating with a walker.

Summary / Conclusion: HBO2 therapy is a valuable adjunct to a team-centered approach to complex surgical and infectious cases.

L 15
Arterial gas embolism or mimic? A case report
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Introduction / Background: Arterial gas embolism (AGE) is a known cause of severe neurologic compromise in divers with uncontrolled ascent. AGE is a clinical diagnosis with importance placed on detailed history, timeline of symptoms and physical exam. Imaging can play an important role in ruling out other etiologies in unclear cases, but imaging should not delay definitive hyperbaric treatment. Thus it is important for clinicians to be able to identify AGE versus mimics and expedite appropriate treatment.

Materials and Methods: We discuss the case of a 60-year-old male recreational scuba diver with stroke-type symptoms after a dive. His exposure, timeline of symptoms, workup and clinical course are reviewed.

Results: The patient originally presented to a local emergency department in Mexico with left hemi-neglect, left-sided paralysis and disjointed speech shortly after surfacing from an 80-foot dive. He had a normal computed tomography (CT) of the head and was given tissue plasminogen activator (tPA) for presumed stroke, complicated by punctate hemorrhagic conversion. He was then repatriated to the United States, arriving at UCSD 36 hours after symptom onset. Preliminary read of CT head and computed tomography angiography (CTA) head and neck showed areas of infarct in the right frontal lobe, the parietal lobe, superior temporal lobe, caudate, internal capsule, and putamen. He was started on a U.S. Navy Treatment Table 6 for a presumed arterial gas embolism, with no improvement. Subsequent overread of the CTA demonstrated right carotid dissection. HBO2 treatment was aborted.

Summary / Conclusion: Hyperbaric recompression is the definitive treatment for AGE. However, AGE is a clinical diagnosis, with bubbles rarely seen on imaging, and diagnosis can be difficult. Here we discuss a case of neurologic symptoms after a scuba dive that was originally treated as ischemic stroke, complicated by hemorrhagic conversion. Hyperbaric therapy was attempted for AGE before final diagnosis of carotid dissection was made. This case highlights multiple AGE mimics including stroke, intracranial bleed and carotid dissection.

L 16
Lessons learned: CO mass casualty
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Introduction / Background: On October 13, 2019, at 1145 hours the Emergency Department at Utah Valley Hospital was notified that local EMS units had responded to a suspected carbon monoxide (CO) incident at a local church. The initial report stated there were some casualties. The fire service reported an ambient CO level of 500 parts per million (personal exposure limit/PEL <50 ppm) inside the building in the area of some classrooms on the west side of the building. The on-call MD for Hyperbaric Medicine was contacted at 1202 hours to alert the Hyperbaric Medicine Service (HMS) of a potential carbon monoxide incident.

Materials and Methods: Due to the number of potential patients, ER physician initiated a Disaster Activation at 1248 hours. HBO2 PA arrived at the ED, evaluated the situation and requested more help from the HMS. Patients were co-located in single rooms with oxygen splitters used to treat up to five per room prior to HBO2. All patients were placed on high-flow oxygen and assessed. The hyperbaric personnel on-call at other nearby hospitals were alerted at 1340 hours to prepare to receive overflow CO poisoning victims. The HMS team assumed split operations, with a treatment team at the chambers and a triage team to remain in the ED to manage incoming patients. The on-call MD developed a triage heuristic based on exposure history, neurological symptoms, and neurological examination. The point of the triage process was to separate the patients into three categories: transfer to another facility, hold for later treatment, and observation of borderline cases.

Results: Efforts were made to manage most of the regularly scheduled hyperbaric patients while addressing/evaluating/treating persons involved with the CO emergency. Multiple follow-up patient status phone calls were placed/received by team members to address concerns or ongoing symptoms associated with CO exposure. Table 1 shows the workload during the CO event period.
Summary / Conclusion: Upon conclusion of the event, discussions were held referencing the importance of Activation and Alert, Emergency Department Operations and Transfer Coordination, Triage/Identification of Injured Patients, Data Management, Coordination with Hospital Administration, Demobilization, and Documentation.

L 17
Two cases of complex open abdomen treated using a combination of surgical debridement, negative-pressure wound therapy and hyperbaric oxygen therapy
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Introduction / Background: Hyperbaric oxygen (HBO2) therapy is indicated for the enhancement of healing in problem wounds where there are arterial insufficiencies or infection. Availability of treatment varies geographically in the UK and can also depend upon clinicians' understanding of the treatment and the availability and quality of evidence. Two cases of non-healing open abdomen treated with HBO2 therapy at a unit in Plymouth, UK, were reviewed to assess outcome.

Materials and Methods: Records of two cases were scrutinized to assess outcome following treatment.

Results:
• Case 1: A 53-year-old morbidly obese lady presented with abdominal pain and was taken to theatre (OR) for an emergency laparotomy and repair of complex strangulated hernia. After 10 days the patient was readmitted to hospital and the subumbilical area of wound dehisced. The tissue viability team managed the wound alongside the surgeons. Care was complicated by the patient’s obesity, reduced oxygenation due to sleep apnea and low hemoglobin. The patient was referred for HBO2 therapy and received 40 treatments with interruptions due to surgery. The wound healed five months after completion of HBO2.
• Case 2: A 44-year-old obese gentleman had perforated diverticular disease and underwent a Hartmann’s procedure. An elective reversal and mesh repair of the abdominal wall was performed, with dehiscence occurring 18 days postoperatively. Washout was performed and negative pressure wound therapy applied to the open wound. A referral was made for HBO2, and 25 treatments were administered. The wound reduced in size. Unfortunately, the patient became unwell and could not attend for treatment. He completed two further HBO2 sessions before opting for plastics intervention rather than waiting for the wound to heal by secondary intention.

Summary / Conclusion: Both cases showed complex wounds that progressed toward healing when a combination of therapies was applied. Good communication between teams and with the patients is key to ensuring successful implementation of such a treatment plan.

L 18
Diving with diffuse cystic lung disease: A case of a diver who has hundreds of dives with confirmed pulmonary cysts without barotrauma
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Introduction / Background: The relationship between cystic lung disease and diving has traditionally been identified as increasing the risk of barotrauma. Commercial, scientific, and military institutions have disqualified anyone with this condition. There are, however, few cases describing the complications of divers with cystic lung disease, especially when identified by computed tomography (CT) alone. With the increasing use of chest CTs, cystic lung disease is being increasingly encountered in clinical practice, necessitating further understanding of diving sequelae in this patient population. There are theoretical differences in risk of pneumothorax between various cystic diseases versus bullous disease.

Materials and Methods: This case report describes an experienced diver incidentally diagnosed with diffuse cystic lung disease. Available dive history and medical chart will illustrate the risk of pulmonary barotrauma and the absence of dive accident.

Results: CT of the chest to stage rectal cancer in a 72-year-old female non-smoker discovered numerous thin-walled pulmonary cysts throughout all lung fields. No metastases were seen. Subsequent chest CT five years later showed no interval change in her diffuse
cystic lung disease. The patient had no recollection of diagnosis of lung disease after initial CT nor remembers receiving any medical advice typically provided with a finding of cystic lung disease, including to modify lifestyle. The patient recorded over 400 scuba dives and multiple airline flights without any symptoms in the five-year interval between chest CTs.

**Summary / Conclusion:** Current understanding of cystic lung diseases suggest that responses to changes in pressure, such as experienced with diving, increase the risk of pulmonary barotrauma. However, pulmonary cysts can be found in a wide variety of disease states with different pathophysiologic mechanisms and should therefore not all be viewed through the same lens. Our case illustrates the complexity of cystic lung disease and that someone with profound radiographic cystic disease can perform hundreds of dives without issue.

**L 19**

**Middle ear barotrauma associated with reverse block, causing SSNHL in HBO2 attendant**

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**Introduction / Background:** Numbers of adverse events in hyperbaric attendants are very low. We describe an atypical presentation of reverse block leading to sudden sensorineural hearing loss in an HBO2 attendant.

After experiencing the flu, bronchitis and sinusitis an RN inside tender experienced mild right ear pain on ascent. On arrival to surface the attendant suddenly lost 100% of hearing in the right ear. On inspection, there was no obvious barotrauma or effusion. The attendant reported symptoms of dizziness and tinnitus but denied otalgia. While waiting to see ENT (three hours) hearing slowly started to return. The attendant decided to see if hearing would return completely and did not see ENT until 48 hours later. Attendant did not dive for one month, and upon resuming diving, the opposite ear (left) had trouble equalizing with otalgia and resulting barotrauma on ascent.

**Materials and Methods:** After hearing loss the attendant saw ENT 48 hours later. Testing demonstrated a normal tympanogram and mild sensorineural hearing loss, with a 30-decibel loss in two fields and 25 decibels in one field. The attendant was treated with steroid injections in the tympanic membrane. Repeat audiogram one week later demonstrated improvement but not a return to baseline. After resuming diving, patient had barotrauma and otalgia in the left ear, so a third audiogram was done which demonstrated normal hearing in both ears. ENT reviewed the benefits and risks of pressure equalizing tubes, but the attendant declined.

**Results:** After two weeks of no diving following left ear barotrauma, the attendant was cleared to dive. A plan was put in place to pre-medicate with Afrin and Sudafed and to use equalization techniques on both the ascent and descent. The tender was successful, with no barotrauma on exam and no further difficulties.

**Summary / Conclusion:** This is an atypical case in a hyperbaric attendant where a prolonged illness led to Eustachian tube dysfunction, reverse block and SSNHL. After a prolonged course, the attendant was successfully able to return to job duties with a dive plan in place, to continue with Flonase and to use techniques for equalization not only during descent but also on ascent.

**L 20**

**Case series of carbon monoxide poisoning resulting in ST elevation myocardial infarction**

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**Introduction / Background:** Carbon monoxide (CO) is an odorless, colorless, tasteless gas which at toxic levels leads to neurological and cardiovascular injury. Reported cardiac manifestations of CO exposure include arrhythmias, cardiomyopathy, myocardial injury, and myocardial infarction. While the neurologic sequelae of CO toxicity are well known, cardiovascular injury with ST elevation myocardial infarction (STEMI) is rare and the pathophysiology is less understood. STEMI in CO poisoning can occur in the presence or absence of complete coronary occlusion. In this study, four patients with CO poisoning leading to STEMI are described.
**Materials and Methods:** We reviewed the medical records of four different patients who presented to our emergency department after CO poisoning and who required cardiovascular intervention and hyperbaric oxygen treatment.

**Results:** All four patients presenting with STEMI after CO poisoning required cardiac intervention with stent placement or attempts at stent placement.

**Summary / Conclusion:** All patients presenting with CO poisoning should receive an EKG. Cardiac catheterization should be highly considered for patients presenting with STEMI from CO poisoning.

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**Introduction / Background:** Acoustic neuroma is a benign, usually slow-growing tumor. Treatments include surgical resection and radiation therapy (e.g., stereotactic radiosurgery, which delivers a precisely targeted dose of radiation to the tumor).

**Materials and Methods:** A 56-year-old female had subtotal resection of a left acoustic neuroma approximately nine years and stereotactic radiosurgery (12.5 Gy) eight years prior to hyperbaric consultation. She had no tumor recurrence but experienced progressive neurologic symptoms, primarily worsening balance with difficulty walking. In the absence of other explanations, her worsening symptoms were thought to be due to soft tissue radionecrosis. MRI showed T2 FLAIR hyperintensity in the left lateral cerebellum and left pons, although these findings could not be positively correlated with her symptoms. A trial of hyperbaric oxygen was prescribed. Response was monitored by having her perform heel-to-toe walking weekly.

**Results:** Initially the patient was unable to walk heel-to-toe and had difficulty with balance. After 23 HBO2 treatments she did four to five heel-to-toe steps on her own, and noted more confidence in her balance. At 32 HBO2 treatments she was able to complete eight heel-to-toe steps. Following 36 HBO2 treatments she felt the rate of progress had slowed. She completed 40 hyperbaric treatments over approximately eight weeks. Follow-up imaging showed no discernable change from pre-HBO2. Seven months after completion of HBO2 therapy, the patient reported "doing really well," with no deterioration, and a possible slight continued improvement in balance. She can babysit her granddaughter because she feels confident in her ability to maintain her balance. She feels this is a huge benefit for her quality of life.

**Summary / Conclusion:** Hyperbaric treatment for possible central nervous system soft tissue radionecrosis resulted in reduced symptoms and marked improvements in this patient’s quality of life. Objective measures are needed in these cases to help guide treatment decisions.

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**Introduction / Background:** Isocyanates are the raw materials that make up all polyurethane products. Isocyanate is a powerful irritant to the mucosal membranes in the respiratory tract, eyes and skin. Pulmonary symptoms, especially occupational asthma, are the predominant manifestations after isocyanates toxicity.

**Materials and Methods:** We report mental change and compartment syndrome complicated by rhabdomyolysis as an extraordinary manifestation of acute isocyanates toxicity during painting/waterproofing water tank. A 58-year-old male recovered consciousness after six hours during an emergency department visit and began to complain of severe pain in both lower legs. The laboratory test revealed a big increase in his creatine kinase (15,250 IU/L) values. Tissue pressure increased to 180mmHg/170mmHg (Rt/Lt) in his lower legs
**Results:** We performed fasciotomy on the second day of hospitalization. Hyperbaric oxygen (HBO2) therapy at 2.0 ATA for 90 minutes was applied twice a day for seven days. His condition gradually improved over six months and he did not require amputation. He was left with only a mild neurological disorder in his foot and was transferred to a rehabilitation center six months after being hospitalized.

**Summary / Conclusion:** Hyperbaric oxygenation therapy was effective as adjuvant therapy in isocyanate-induced compartment syndrome.

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**L 23**

**Role of hyperbaric oxygen in pediatric orofacial reconstruction after radiation therapy: An interdisciplinary case report**

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**Introduction / Background:** Alveolar rhabdomyosarcoma (ARMS) is a common soft tissue cancer in children. Treatment includes radiation, which can cause developmental damage to growing patients. When involving the head and neck region, the facial skeleton and dentition may be severely affected, resulting in orofacial reconstruction challenges.

**Materials and Methods:** A 3-year-old female presented to the Mayo Clinic in 2007 with respiratory symptoms and a left nostril lesion. Biopsy confirmed ARMS of the left nasolabial fold. She received 3,600 cGY of radiation over 20 fractions. During subsequent examinations, maxillary hypoplasia, agenesis of four permanent teeth and arrested root development of 10 permanent maxillary teeth was found.

**Results:** Orofacial reconstruction was initiated at age 14 in collaboration between Mayo Clinic Orthodontists, Maxillofacial Prosthodontists, Oral and Maxillofacial Surgeons and Hyperbaric Medicine Physicians. Orthodontics was performed to retrocline the lower dentition, providing positive overjet to facilitate reconstruction of the severely hypoplastic maxilla. An implant-retained full coverage prosthesis was planned for rehabilitation of the maxillary dentition. Implant placement into previously irradiated bone created concerns for wound healing and radionecrosis. Twenty pre-surgical treatment and 10 post-surgical treatments were delivered at 2 ATA for 90 minutes each. Oral surgeons extracted eight permanent maxillary teeth, performed guided bone regeneration and socket preservation grafts and successfully placed four immediate endosseous dental implants.

**Summary / Conclusion:** Hyperbaric oxygen therapy can be a useful adjunct in the complex pediatric orofacial reconstruction after radiation for ARMS.

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**L 24**

**Resolution of oropharyngeal fistula in patient with history of life-threatening bleeding**

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**Introduction / Background:** Soft tissue and osteoradionecrosis are serious complications of radiation therapy which have a significant effect on patient morbidity and quality of life. Radiation damage that reaches large blood vessels can be life-threatening. Hyperbaric oxygen (HBO2) therapy promotes the growth of new microvasculature to correct tissue hypoxia and promote healing in areas of radiation injury.

**Materials and Methods:** Thirteen years after completing definitive chemoradiation therapy for squamous cell carcinoma of the soft palate, this 73-year-old man suffered an episode of massive hemoptysis and required emergency tracheostomy. Initially, the source was thought to be the right brachial artery, which was embolized. Eight months later, the patient experienced a second episode of massive hemoptysis. The source was eventually identified to be an 8mm pseudoaneurysm of the external carotid artery, with a 2cm pyriform sinus fistula extending from the left lateral aspect of the oropharynx to the level of the posterior aspect of the left hyoid bone. The patient underwent coil occlusion of his left external carotid and was referred to Hyperbaric Medicine to assist in healing the fistula.

**Results:** A total of 40 daily HBO2 treatments (90 oxygen minutes at 2.0 ATA) were administered in a monoplace chamber over eight weeks, during which time the patient received no other form of therapy. Barium swallow performed after the final treatment detected no
fistula. The patient reported improvement in his pain level and xerostomia symptoms, as well as weight gain. His tracheostomy was successfully decannulated and healed closed without surgical intervention. He has had no further episodes of bleeding.

**Summary / Conclusion:** Hyperbaric oxygen therapy can improve the morbidity and quality of life of patients with delayed radiation injury. In this case it was important in the management of life-threatening bleeding.

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**L 25**

**Delayed radiation injury of lower extremity treated with hyperbaric oxygen**

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**Introduction / Background:** Radiation therapy is used for a number of malignancies and in a small minority of cases leads to delayed radiation injury. Radiation exposure may lead to acute and chronic dermatitis. In some cases, this becomes a refractory wound. There is very little literature on the treatment of lower extremity wounds cause by delayed radiation injury.

**Materials and Methods:** This is a case report of an 86-year-old female who was treated with radiation for a squamous cell carcinoma of the left leg.  
Patient was exposed to 6,000 cGy, finishing up treatment in January 2018. She developed skin breakdown and failed conservative wound care and skin grafting. Patient presented in October 2018 for evaluation for possible hyperbaric oxygen therapy in conjunction with routine wound care. Patient started on a treatment course of hyperbaric oxygen at 2.4 ATA for 90 minutes with two air breaks during each treatment, with one treatment daily five days a week in a monoplace chamber. Patient completed a course of 40 hyperbaric oxygen treatments.  
The patient continued her conservative wound care with weekly office visits. Her wound care consisted of a chemical debridement ointment (collagenase) for one week, then multilayer compression dressings (Profore) and application of a collagen-based dressing (Prisma) applied on a weekly basis.

**Results:** Over the course of three months and 40 hyperbaric treatments the patient’s lower leg wound healed completely. Patient did not require any additional surgical procedures or skin grafting.

**Summary / Conclusion:** Hyperbaric oxygen has been suggested as a treatment for delayed radiation injury of soft tissue and bony necrosis in the past. There is very little literature for the treatment of cutaneous injuries, especially extremity wounds. This case report adds to the limited number of patients who have been treated and responded to hyperbaric oxygen therapy for cutaneous delayed radiation injuries in the extremities.

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**L 26**

**Aspergillus fumigatus brain abscess treated with adjunctive hyperbaric oxygen therapy**

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**Introduction / Background:** Intracranial abscesses are a rare disease process typically limited to the immunocompromised population. While prior evidence for the use of adjunctive HBO2 therapy for intracranial Aspergillus abscesses is sparse, several case series and case reports in other types of intracranial abscesses suggest improvement in outcomes with adjunctive HBO2.

**Case Description:** We present the case of an 84-year-old previously healthy male treated with adjunctive HBO2 for an intracranial abscess. Several months of right ear drainage prompted otolaryngology to place a myringotomy tube. Progressive headaches and tinnitus later prompted presentation to an outside hospital, where he was diagnosed with an invasive fungal sinus infection and discharged on oral voriconazole. Fungal speciation revealed *Aspergillus fumigatus.*  
He then presented to the ED for worsening headache, tinnitus, fever, weight loss and dysphagia. He was diagnosed with a right temporal lobe intracranial abscess with skull base osteomyelitis and treated with broad-spectrum antibiotic and antifungal therapy. Neurosurgery and otolaryngology initially deemed him not a surgical candidate given the location of the abscess and risk for catastrophic vascular and neurologic injury. He underwent 20 daily adjunctive HBO2 sessions while continuing antifungals.
Interval brain MRIs demonstrated worsening edema, at which point he underwent craniotomy with abscess resection and debridement of skull base osteomyelitis three days after completion of HBO2. He has been discharged with an intact neurologic exam. He will be on a prolonged course of voriconazole, to be followed by infectious diseases. He has ongoing workups regarding a pulmonary nodule and new onset diabetes as possible predisposing factors to this typically opportunistic infection.

**Discussion:** This case demonstrates a rare disease process treated with adjunctive HBO2, culture-directed antifungal therapy, and surgical resection with a good outcome at the time of present follow-up.

End Session L