

# DECOMPRESSION SICKNESS (DCS) -“THE BENDS”

## **Background**

1. Definition: DCS is result of improper decompression after exposure to higher levels of compression (usually diving).
  - Signs and symptoms are normally the result of air bubbles forming in joints and other tissues
    - Cause mechanical and biochemical effects.
2. Decompression Illness (DCI) is a more broad diagnosis that includes DCS and Arterial Gas Embolism (AGE).<sup>1,2</sup>
3. Described for over 200 years
  - Initially in tunnel diggers-Caisson Disease<sup>1,2</sup>
4. Common due to increase in recreational, no-decompression, SCUBA diving
5. Case reports of incidents at altitude not related to diving
  - Normally military aircraft<sup>3</sup>

## **Pathophysiology**

1. Release of inert gasses dissolved into blood stream under high pressure, mostly nitrogen, from physical solution with resultant bubble formation after decompression.
  - Bubbles can have mechanical, embolic and biochemical effects<sup>1,2</sup>
2. DCI includes DCS and AGE.
  - DCS mechanics like Arterial Gas Embolism (AGE) but different symptoms
3. Incidence of non-fatal DCS 0.01% (9.57/100,000 dives)<sup>4</sup>
4. Risk Factors<sup>1,2</sup>
  - Gas burden (“depth and time”); not following dive tables
  - Multiple dives
  - Immersion in water
  - Environment: cold water and higher altitude for SCUBA
  - Obesity
  - Older (over 50)
  - Flying within 12 hours of diving
  - Exercise-at depth and after the dive<sup>5</sup>
5. Morbidity / Mortality<sup>2</sup>
  - 80% will have complete recovery
  - Even with severe DCS only 27% will have long term complications

## **Diagnostics**

1. History
  - See Diving history for more details
  - Detailed history of all dives/times, ascent rates, intervals between dives, breathing gases and complications with dive
  - Symptom times and progression after diver has surfaced from last dive
  - Get detailed first aid information including all measures and their effect on symptoms
  - Record results of neuro exam done on site
  - Describe all joint or other musculoskeletal pain including: location, intensity and changes with movement/weight-bearing
  - Describe distribution of any rashes
  - Describe any traumatic injuries before, during and after dive

## 2. Physical Examination

- No longer divided into types I & II DCS<sup>2</sup>
- Wide range of symptoms
  - Any new symptoms after decompression should be considered as possible DCS<sup>2</sup>
- Neurological Exam is crucial for all DCS injuries
- Pain: most common initial symptom and most common overall<sup>2</sup>
  - 68% of cases
  - 58% joint pains (most common distribution in recreational SCUBA), 35% muscle pains, & 7% girdle pains
  - Joint crepitus/subcutaneous crepitus
- Numbness/paresthesias
  - 63.4% of all cases
  - Can easily be missed if proper neurological exam not performed
- Constitutional symptoms 48% of cases: headache, fatigue, malaise, nausea/vomiting or anorexia
- Cutaneous symptoms
  - 9.5% of cases
  - Pruritus or marbling
- CNS symptoms
  - Cerebral DCS<sup>1,2</sup>
    - Seizures, hemiplegia, diplopia, tunnel vision or scotomas
    - Progress to AMS (altered mental status), coma or death
    - 18.7% of all cases have weakness
    - Less than 8% have other findings
    - 27% of CNS DCS will still be present at one month
  - Labyrinthine involvement (“the staggers”)
    - Vertigo, nausea, vomiting, deafness, tinnitus and nystagmus
    - Immediate treatment important due to small vasculature
    - Must exclude inner ear barotrauma (Electronystagmography)<sup>6</sup>
- Pulmonary symptoms (“the chokes”)
  - Massive blocking of pulmonary circulation by bubbles
  - Substernal pain, cough and dyspnea
  - Usually occurs within minutes
  - 5.6% of cases
  - Can lead to respiratory failure and shock if not treated immediately
- Other less common symptoms include bladder, bowel, GI and cardiovascular symptoms.

## 3. Diagnostic Testing

- Neuropsychiatric testing for evaluation of subtle CNS findings

## 4. Laboratory evaluation by recommendation of Undersea and Hyperbaric Medicine Society (UHMS)<sup>6</sup>

- CBC: evaluate for DIC
- BMP: evaluate for hypoglycemia
- Toxicology screen: evaluate for other causes
- CPK: some evidence shows AGE elevated vs. normal in DCS

## 5. Diagnostic imaging

- Plain film imaging: evaluate for gas
- Electronystagmography: decide inner ear DCS vs. barotrauma

6. Diagnostic criteria
  - SANDHOG and RNZN, two clinical scales previously studied to help diagnose DCS
    - Limited clinical usefulness<sup>7,8</sup>

## Differential Diagnosis

1. Key Differential Diagnoses
  - Inner ear barotrauma
  - Middle ear/maxillary sinus over-inflation
  - Contaminated diving gas
  - Oxygen toxicity-especially with use of Nitrox
  - MSK strains
  - Seafood toxin ingestion
  - Immersion pulmonary edema
  - Water aspiration

## Therapeutics

1. Acute Treatment
  - Surface Oxygen 100% NRB facemask (SOR: C)<sup>9</sup>
    - Do not use ENTOX (50% O<sub>2</sub> 50% N<sub>2</sub>) as this can exacerbate pneumothorax
  - In-water recompression should only be done in remote areas<sup>10</sup>
  - US Navy (USN) and UHMS guidelines support recompression then controlled decompression following USN Dive Table 6<sup>2,6</sup>
    - Hyperbaric Oxygen
    - Reduces bubble size and improves absorption
    - Reverses tissue hypoxia
  - Contact Diver's Alert Network (DAN) at 919-684-9111
  - NSAID's show conflicting evidence (SOR: C for ASA and SOR: B for ibuprofen)<sup>9</sup>
  - IV fluids bolus NS or LR (SOR: C)<sup>9</sup>
2. Further Management (24 hrs)
  - May require repeat chamber trips
  - Use LWMH for those with leg immobility (SOR: A)<sup>9</sup>
  - Conflicting data for IV lidocaine as adjunct to HBOT (SOR: B)<sup>9</sup>
  - Do not use steroids (SOR: B)<sup>9</sup>
  - Transport via ground if possible
    - Aircraft maintain maximum cabin altitude of 1000 ft above sea level<sup>11</sup>
3. Long-Term Care
  - All patients should be transferred to facilities with hyperbaric oxygen chamber

## Follow-Up

1. With mild and moderate DCS divers normally can return to sport in 4 weeks
2. Severe DCS, with cerebral DCS or continued symptoms, should not return to diving until cleared by a Diving Medical Specialist

## Special Situations

1. DCS in free divers
  - Rare

- Multiple dives with short surface intervals
- See above for treatment

### **Prevention**

1. All divers should have pre-dive medical clearance
2. Safety stops (3-5 minutes at 10-20 feet)
3. Ascend slowly ( $\leq 30$  ft/min)
4. Use a dive computer/dive table
5. Plan dive carefully
6. Keep fit, well hydrated and avoid alcohol
7. No flying until 12 hours after a single dive
8. No flying until 18 hours after a series of multiple dives

### **Patient Information**

1. Diver's Alert Network-Medical Frequently Asked Questions

### **References**

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**Author: Travis C. Russell, MD, & J. David Honeycutt, MD, Nellis AFB, NV**

**Editor: Carol Scott, MD, University of Nevada Reno FPRP**