

## ICDOTS

### Isobaric Counter Diffusion on the surface

As I home in on the last few DCS niggles that effect Trimix divers, such as post dive tiredness, and unearned DCS coming on some time after the dive ends (regardless of what decompression algorithm the diver was following) I've made a recent theoretical discovery triggered by investigating another friends serious unearned DCS hits that I'd like to pass on to you.

It's this;

A few years a go, as I was developing the math to prevent ICD hits in Ultra deep Trimix stunt dives by using either a zero ppN<sub>2</sub> gas switch rule or a 1/5th rule for percentage change in Nitrogen/Helium in the breathing mix during gas switches at the deco ceiling, my math (which correctly suggested the solution to avoid the ICD problem during the dive) kept giving what I thought was an anomalous ICD hit prediction when switching off pure Oxygen and returning to breathing air after completing the deco on the surface. I'll term this an 'ICD Hit on the Surface' or ICDOTS

However, I am rapidly coming to the conclusion though, that this anomalous surface ICDOTS prediction (when coming off pure Oxygen and returning to breathing air on the surface) is, in fact, a true valid prediction of an ICD hit. I have now examined several post dive unearned bends occurrences for divers following different decompression algorithms, and the time scales in which their symptoms become apparent; it seems that **coming directly off pure O<sub>2</sub> at the surface is not a good thing**. Of course, old Trimix divers have always recommended staying on pure oxygen for 15mins-30mins after a dive as being a good thing. I wonder if this 'folk law' has a basis in ICD?

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The ICD avoidance math anomaly observed in the CDM algorithm suggests that a gradual increase in Nitrogen content in the breathing gas is again required *even on the surface(post dive)* to prevent a ICD hit occurring.

Looking into the problem and the evidence more closely, it is seen that if the diver has correctly decompressed (according to whatever algorithm he has been decompressing on), then at the end of the dive, all fast tissues are normally fully flushed out. Only the slower tissues remain super saturated(with the final slow controlling tissues sitting setting the end of dive point) It is usually these supersaturated slow tissues that suffer the ICD hit, and interestingly, it is also observed that the time scale for the appearance of the unearned DCS(as either type I or Type II) is also in the order of 30mins-3 hours(for a normal twin tank dive utilizing multiple deco gases), directly matching the half-times of the tissues suffering the ICD insult. A very interesting coincidence.

## So how to prevent the unearned ICDOTS bends ?

I postulate the following:-

- The first step appears to be the recognition that a step increase in ppN<sub>2</sub> has just as much potential to cause an ICD incidence whether the diver is underwater or on the surface, especially when he is sitting at the ascent ceiling just after surfacing.
- That due to the slow half time of the controlling tissues suffering the ICD hit, there will be a quite long delay (typically 30mins-3 hour) time interval between observed symptoms.
- That to avoid ICDOTS the decompressing diver breathing pure oxygen must gradually switch back to breathing air using a protocol of breathing different gases with gradually increasing nitrogen contents breathed for periods that allow the controlling long half time tissues sufficient time to flush out prior to breathing the next gas.
- That the surface breathing protocol to avoid ICDOTS is dependent on the dive just carried out. Deeper, longer dives will need longer more gradual surface breathing gas switches to prevent ICDOTS, due to the saturation of the sensitive longer half time tissues.

I have yet to run typical profiles through the CDM analyzer to determine the surface gas switching protocol to prevent ICDOTS for different dive depths and to take into account all breathing gas variations.

However it should be possible to create a simple ICDOTS avoidance planner that would appear roughly as shown below as a likely solution for twin tank deco dives (Note Multi-hour rebreather dives or saturation exposures would likely a custom solution)

### Deco Dive                      ikely Surface Decompression Gas switching required

10-30 meters            30 mins surface O<sub>2</sub> then onto air

40-60 meters            30 mins surface O<sub>2</sub> followed by 30 mins surface Nitrox 50 then onto air

60-80 meters            45 mins surface O<sub>2</sub> followed by 45 mins surface Nitrox 50 then onto air

80-100 meters            60 mins surface O<sub>2</sub> followed by 60 mins surface Nitrox 50 then onto air

100-150 meters            90 mins surface O<sub>2</sub> followed by 90 mins surface Nitrox 50 followed by 90mins Surface Nitrox 32 then onto air

150-200 meters            120 mins surface O<sub>2</sub> followed by 90 mins surface Nitrox 50 followed by 90mins Surface Nitrox 32 then onto air

Note, that **the above table is only my guess** and has not had any formal CDM investigation done to prove the figures yet. However, a final ICDOTS avoidance table would likely be very similar to this.