



THE PROBABILITY AND SEVERITY OF DECOMPRESSION SICKNESS (DCS)

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INTRODUCTION

- ❖ Serious DCS (cerebral, motor, objective sensory) is of greater concern than mild DCS (subjective sensory, pain, cutaneous, constitutional), and each has a different acceptable DCS probability. For example, the U.S. Navy (USN) desires not more than a 0.02 (2%) probability of mild DCS and 0.001 (0.1%) probability of serious DCS (1).
- ❖ Distinction by severity makes DCS probabilities trinomial (no DCS, mild DCS, serious DCS) rather than binomial (no DCS, DCS).
- ❖ We tested the hypothesis that the probabilities of mild and serious DCS are quantitatively distinguishable. We illustrate the consequences for no-stop dives.

METHODS

- ❖ Thalmann's "linear-exponential" (LE) model (2) was adapted for use with trinomial probabilities.
- ❖ Models were fitted to calibration data ('Temple') that included 8,578 dives with 434 binomial DCS cases (4) having trinomial equivalents of 382 mild and 52 serious cases.
- ❖ Two sets of trinomial equations were evaluated (Table 1). The binomial probability model was a subset of the trinomial models.
- ❖ Since the binomial and trinomial data were different, the likelihood ratio test could not be used to compare maximum log likelihoods (LL_{max}).

Table 1. DCS probability models

Binomial Model	
$P(\text{no DCS}) = e^{-r_{\text{rdt}}}$	
$P(\text{all DCS}) = 1 - e^{-r_{\text{rdt}}}$	
$r = \text{"instantaneous risk" from (2)}$	
Trinomial Model #1 (3)	Trinomial Model #2
$P(\text{no DCS}) = e^{-a/r_{\text{rdt}}}$	$P(\text{no DCS}) = be^{-r_{\text{rdt}}}$
$P(\text{mild DCS}) = e^{-r_{\text{rdt}}} - e^{-a/r_{\text{rdt}}}$	$P(\text{mild DCS}) = (1 - b)e^{-r_{\text{rdt}}}$
$P(\text{serious DCS}) = 1 - e^{-r_{\text{rdt}}}$	$P(\text{serious DCS}) = 1 - e^{-r_{\text{rdt}}}$
$a = 8.7$ (fitted parameter)	$b = 0.87$ (fitted parameter)

RESULTS

- ❖ Binomial model (all DCS)
 - ❖ $LL_{max} = -2,281.7$
 - ❖ Cases predicted: 433.8 ± 37.4 (95% confidence interval)
- ❖ Trinomial model (mild and serious DCS)
 - ❖ Model #1 $LL_{max} = -1,695.2$
 - ❖ Cases predicted: 51.7 ± 14.0 serious & 382.7 ± 36.6 mild
 - ❖ Model #2 $LL_{max} = -1,703.6$
 - ❖ Cases predicted: 52.2 ± 14.1 serious & 383.0 ± 36.7 mild
- ❖ Figure 1 shows the observed DCS incidence plotted against the predicted DCS probability for composite groups of 860 dives.
 - ❖ The line of identity is shown for comparison with the 95% confidence intervals around the observed DCS.
 - ❖ The 95% confidence intervals for binomial DCS did not intersect the line of identity.
 - ❖ Mild and serious DCS probabilities approximated the line of identity more closely than binomial probability.

ACKNOWLEDGMENT

Supported by NAVSEA Contract N61331-06-C-0014.

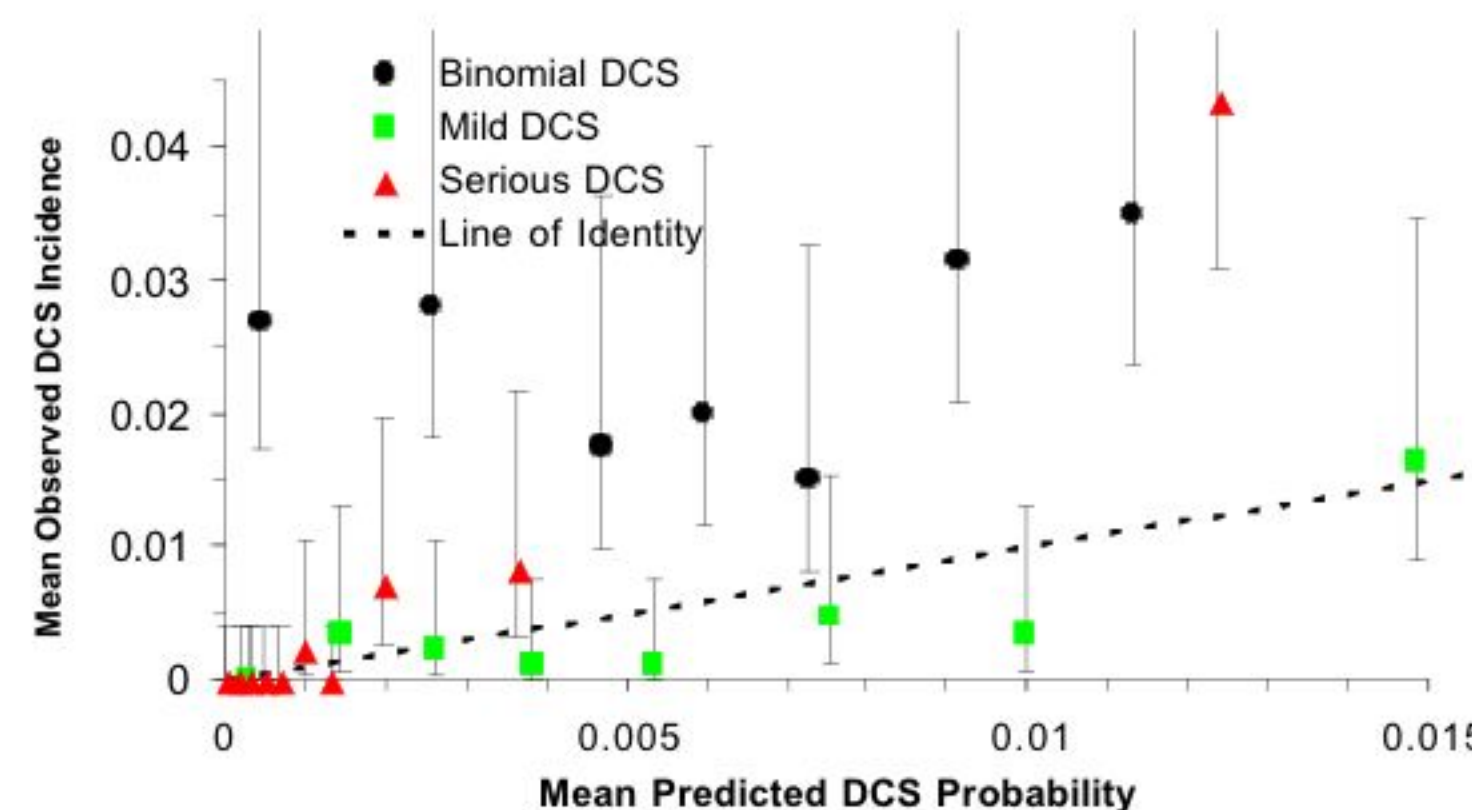


Fig. 1. Observed vs. predicted DCS

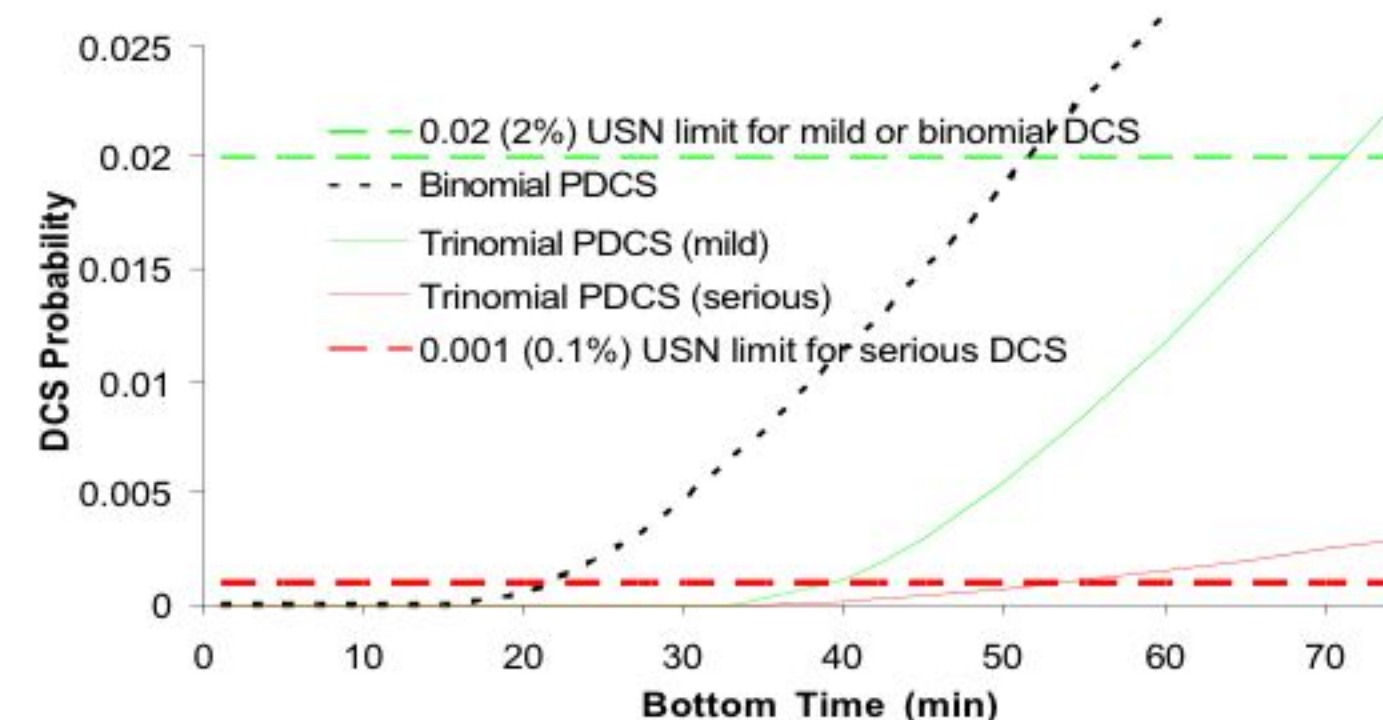


Fig. 2. DCS probabilities for 60 fsw no-stop dives

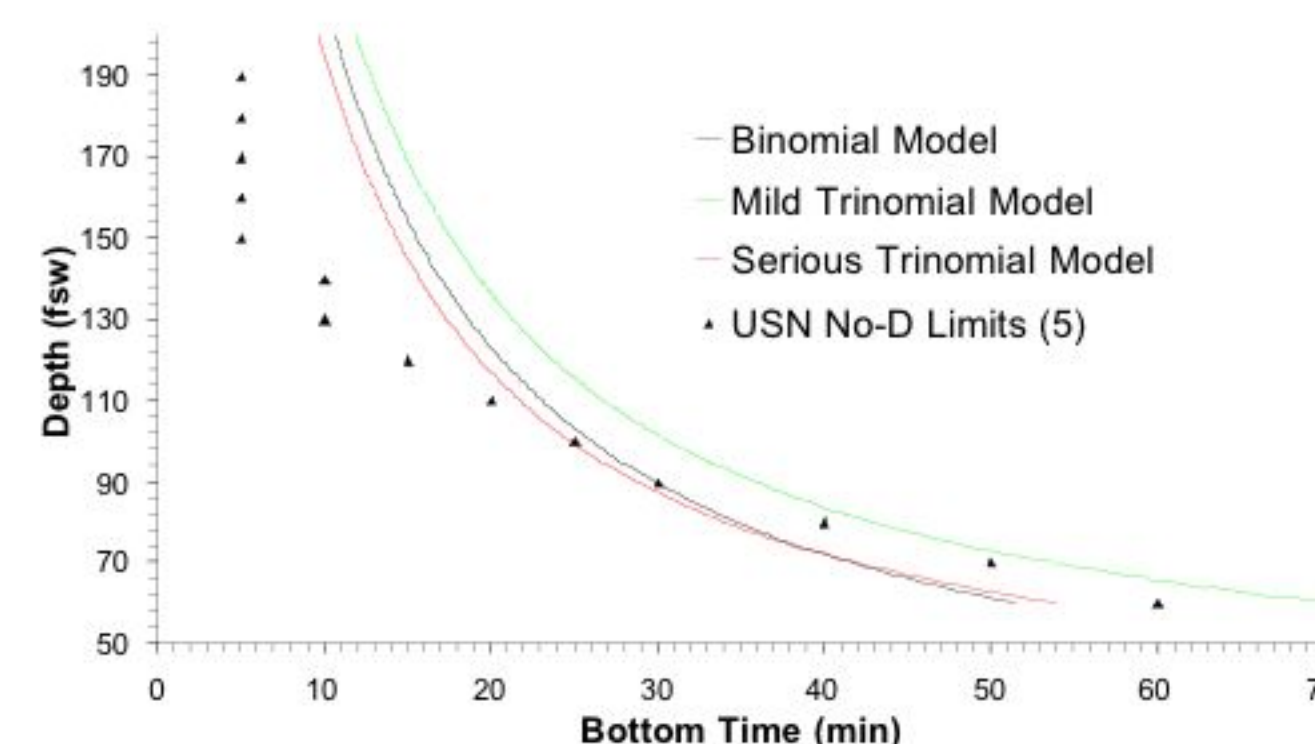


Fig. 3. No-stop exposure limits for air diving

DISCUSSION

- ❖ Figure 2 shows binomial, mild, and serious DCS dose-response curves for no-stop dives to 60 fsw.
 - ❖ Acceptable USN DCS probabilities (1) appear in Fig. 2 as horizontal lines.
 - ❖ Mild DCS was more likely than was serious DCS.
 - ❖ The dose-response curves of Fig. 2 were significantly different for other calibration data ('BIG292'; 6).
- ❖ The 60 fsw no-stop bottom times that satisfied acceptable USN probability limits were:
 - ❖ 52 min for binomial DCS (0.02 (2%) USN acceptable limit)
 - ❖ 71 min for mild DCS (0.02 (2%) USN acceptable limit)
 - ❖ 54 min for serious DCS (0.001 (0.1%) USN acceptable limit)
- ❖ Figure 3 shows the no-stop limits for air diving.
 - ❖ No-stop limits for serious DCS were 18-24% shorter than for mild DCS.

CONCLUSIONS

- ❖ Mild and serious DCS have quantitatively different probabilities as determined by calibrating the LE model (2) to the Temple data (4).
- ❖ Application of acceptable DCS probability limits to mild and serious DCS probability estimates suggested that predicted decompression procedures may differ according to DCS severity.
- ❖ LE model predictions depend strongly on calibration data.

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