

Reducing the risk of drowning after helicopter ditching: an assessment of the performance of three emergency breathing systems



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Background...

14 Million People



2 Million Passenger Movements



- **KEY POINT:** What is the main risk associated with cold water immersion and submersion?

Immersion and Submersion Summary

Respiratory

Gasp Response	→	↓ Breath Hold Time
Inspiratory Shift	→	Difficulty in breathing
Hyperventilation	→	Muscle spasm ("Tetany")

Cardiovascular

Tipton, 1989

Peripheral Vasoconstriction	→	Hypertension
Tachycardia	→	↑ Cardiac Workload
Adrenal Stress Hormones	→	Arrhythmias

Submersion

Tipton et al, 2010

Cold stimulation of the skin and trigeminal nerve	→	Dive response
Apnea	→	Arrhythmias & sudden death

Risk Management....

Training



Survival Equipment: EUBS



Literature basis for EUBS tests....

- Few published studies to date
- No agreed standard for testing EUBS despite evident need
- No published comparisons of more than 2 EUBS (Tipton et al., 1997)
- Comparisons not made for >70 s; literature suggests requirement is ~ 92 s (Cheung et al., 2001)

Research Questions and Aims...

- Quantify the performance of 3 commercially available EUBS design concepts
- Develop a standard protocol for testing present and future EUBS
 - Immersion vs. Submersion
 - Cool (25°C) vs. Cold (12°C) water
 - Which performance measures to include?
- Hypothesis: CG device would enable longest stay time



Relevant Performance Questions...

- a. How quickly can my EUBS be deployed; which EUBS is best?
- b. How long will the EUBS enable me to protect my airway in or under the water; which EUBS concept is best?
- c. What aspects of the present protocol should be included to test future performance of EUBS?

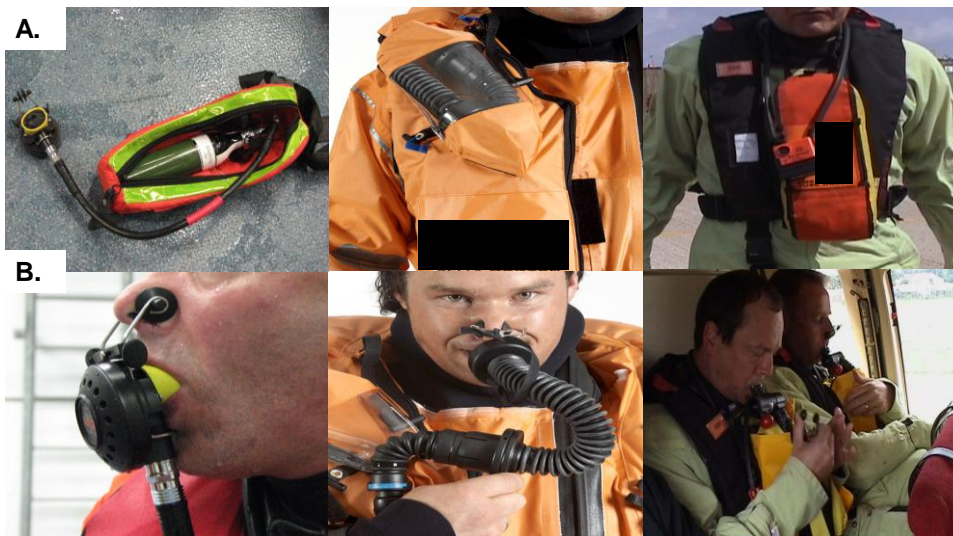
Methods

- Male (5) and female (3) adult participants

	Age (years)	Height (m)	Mass (kg)
Overall ($n=8$)	25.0 (4.5)	1.74 (0.1)	70.1 (8.7)

- Three commercially available EUBS
- Training/familiarisation
- Six EUBS trials in cold water
 - Deployment
 - Stay time on surface
 - Stay time on bottom (Subm)
- Maximum duration 90 s






Example EUBS stored (row A) and deployed (row B):

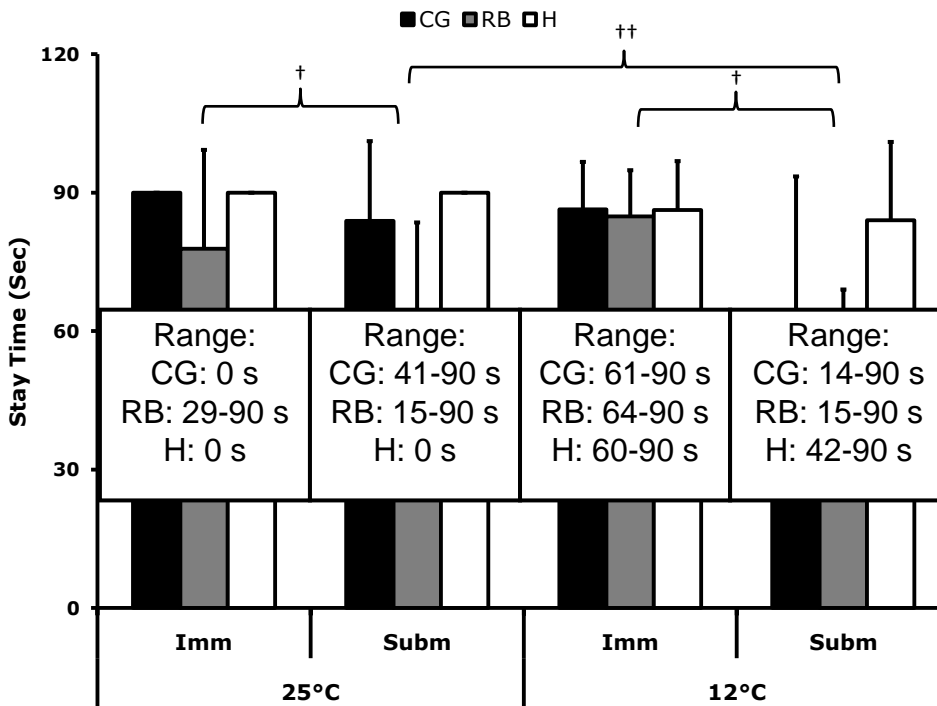
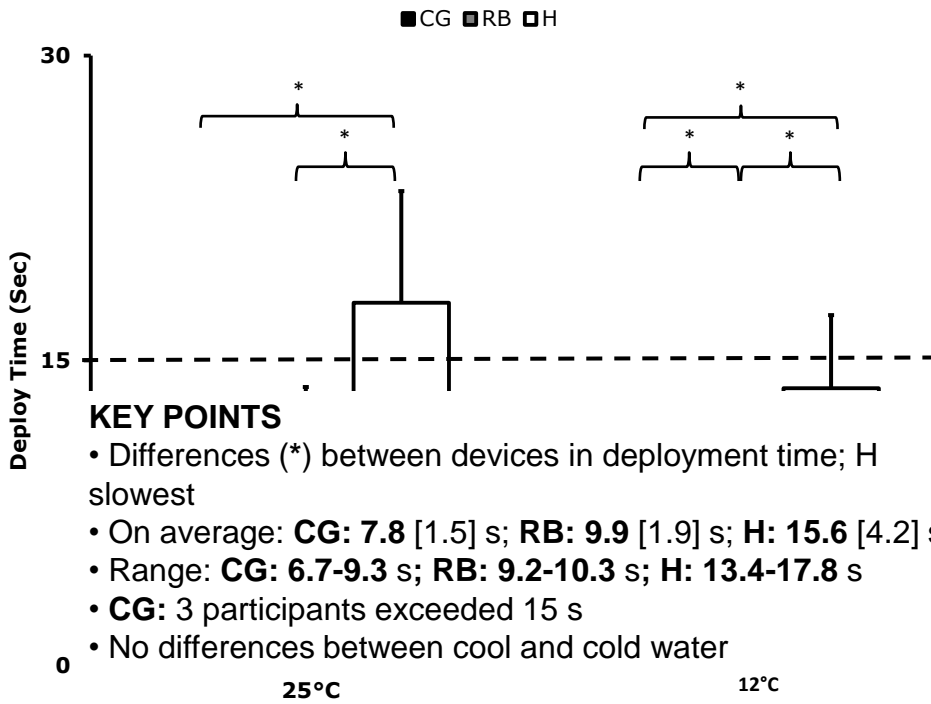
**Compressed
Gas (CG)**

**Re-Breather
(RB)**

Hybrid (H)


Measurements

- **Performance:** EUBS deployment time, stay time
- **Specific EUBS Performance:** Fractional expired gas concentrations (RB & H), gas breathed (CG)
- **Physiological Responses:** In test f_c including ECG waveform and skin temperature
- **Perceptual Responses:** Dyspnea rating (10 cm visual analogue scale), device ease of use and comfort, breathing ease and comfort; overall confidence





Relevant Performance Questions...

- a. How quickly can my EUBS be deployed; which EUBS is best?

7.8 to 15.6 s

BEST: COMPRESSED GAS

- b. How long will the EUBS enable me to protect my airway in or under the water; which EUBS is best?

68.3 to 87.6 s

BEST: HYBRID

- c. What aspects of the present protocol should be included to test future performance of EUBS?

SUBMERSION

COLD WATER?

DEPLOYMENT



Discussion and Conclusion

- Quantify the performance of 3 commercially available EUBS design concepts
- Develop a standard protocol for testing present and future EUBS
 - Immersion vs. **Submersion**
 - Cool (25°C) vs. **Cold (12°C) water?**
 - Which performance measures to include
- Hypothesis: CG device would enable longest stay time: **REJECTED**
- CG and H would meet the demands of the user in an emergency scenario



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References

Full list of citations in:

- Barwood, M.J., Corbett, J., Coleshaw, C., Long, G., & Tipton, M.J. (2010). *Aviation , Space and Environmental Medicine*, 81: 1002-1007.