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P4_6 Buried Alive

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Abstract

Situations in which a character in a film or TV program has been buried alive appear commonly, for example David Blaine was entombed for a week as an endurance feat. This paper calculates how long a human can survive in a casket without an external air or water supply. A value of 11 hours was calculated for a human perfectly at rest. A value of 41 minutes obtained if the human was distressed and respiring at the maximal rate. The length of time in the casket is determined by the human's activity.

Introduction

A person buried alive with a finite time to be rescued or escape is a common scenario in many films and TV programs. Some people may agree to be voluntarily buried alive for good luck. In 1999 David Blaine performed an endurance feat of being entombed in a plastic coffin for seven days. He ate nothing and only drank two to three tablespoons of water a day [1]. This article will examine the length of time a human could survive without an external water and air supply in a casket.

Analysis

In the situation analysed it was assumed that the human would be in the casket at rest. He would have a mass of 70 kg and his body would occupy a volume of 0.18 m^3 (1.82 m x 0.50 m x 0.20 m).

A human body at rest must expend a minimum amount energy to remain alive. This energy is needed to supply the vital organs. The energy produced is released as heat and is calculated by the basal metabolic rate (BMR) (1) [2].

$$BMR = 4.06\mathrm{M}^{0.68}, \qquad (1)$$

where M is the mass of a mammal. A BMR of 73 W is obtained for the model human. To sustain the above calculated BMR energy would have to be released from the human respiring. Assuming energy released within the body from oxidation is 20 J ml^{-1} [2]. The oxygen intake required for the human to maintain the BMR can therefore be calculated as 3.1 ml kg^{-1} min^{-1}.

An average casket has an internal volume of 0.89 m^3 [3]. Figure 1 shows the human casket configuration. Using the above figures there will be approximately 710 x 10^3 ml of air available. Oxygen constitutes 20 % of air [4], so the human will have approximately 140 x 10^3 ml of oxygen available for respiration.

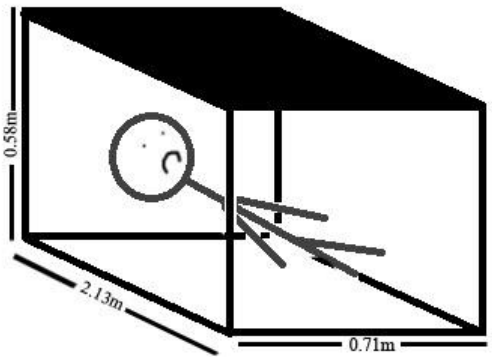

Figure 1 Human and casket configuration.

The length of time a human could survive for in the casket using the calculated oxygen intake would be about 11 hours.

Issues

The value calculated for oxygen consumption would be expected to increase in a real life

situation. This would be due to the entombed human feeling distressed and naturally trying to escape. For a human in a distressed psychological state, the maximal rate of respiration will be assumed. Assuming the human was a male in their 20's and was respiring at maximal rate of 52 ml kg^{-1} min^{-1} [5]. Then for the assumed mass of 70 kg the human would have 41 minutes to survive.

In the analysis section the assumption was made that all of the oxygen breathed in by the human would be replaced with carbon dioxide. This would not be the case with about 15 % [6] of oxygen being exhaled the amount of time would increase slightly ~ 6 minutes. This was an acceptable assumption for the analysis as an order of magnitude value was required.

Conclusion

To conclude, from the calculations performed, a human perfectly at rest will have more time, 11 hours, in the coffin due to lower oxygen consumption. This would be an idealised situation where the human would not be in a disturbed state. The stress in a real life situation will increase oxygen consumption rate, reducing survival in the worst case scenario to 41 minutes.

References

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[6]http://www.oxygen-review.com/respiration.html [Accessed 8 November 2011]