

Title page includes title, your name, course, and date, all centered on page.

The Role of Hypothermia and the Diving Reflex in Survival of Near-Drowning Accidents

Brian Martin

Biology 281  
April 17, 1995

Short title and page number in upper right corner.

Top, bottom, right and left margins should be between 1 and 1.5 inches.

One-paragraph abstract concisely summarizes major points.

Introduction gives aims and scope of paper.

In the citation-sequence system of the CBE documentation style, superscript numerals indicate cited material.

## Hypothermia and Diving Reflex 2

### ABSTRACT

This paper reviews the contributions of hypothermia and the mammalian diving reflex (MDR) to human survival of cold-water immersion incidents. The effect of the victim's age on these processes is also examined. A major protective role of hypothermia comes from a reduced metabolic rate and thus lowered oxygen consumption by body tissues. Although hypothermia may produce fatal cardiac arrhythmias such as ventricular fibrillation, it is also associated with bradycardia and peripheral vasoconstriction, both of which enhance oxygen supply to the heart and brain. The MDR also results in bradycardia and reduced peripheral blood flow, as well as laryngospasm, which protects victims against rapid inhalation of water. Studies of drowning and near-drowning accidents involving children and adults suggest that victim survival depends on the presence of both hypothermia and the MDR, as neither alone can provide adequate cerebral protection during long periods of hypoxia. Future lines of research are suggested and related to improved patient care.

### INTRODUCTION

Drowning and near-drowning incidents are leading causes of mortality and morbidity in both children<sup>1</sup> and adults.<sup>2</sup> Over the past 30 years, there has been considerable interest in cold-water immersion incidents, particularly the reasons for the survival of some victims under seemingly fatal conditions. Research suggests that both hypothermia and a "mammalian diving reflex" (MDR) may account

Hypothermia and Diving Reflex 3  
for survival in many near-drowning episodes.<sup>3</sup>

However, the extent to which these two processes interact is not fully understood. Controversy also exists regarding the effect of the victim's age on the physiological responses to cold-water immersion. In this paper, I provide an overview of recent research on the protective value of hypothermia and the diving reflex in cold-water immersions. I also examine hypotheses concerning the effects of age on these processes, and conclude with suggestions about future lines of research that may lead to improved patient care.

Introduction ends with concise plan of paper.

Headings help organize text.

Reference to two sources.

Data from primary sources summarized and integrated into text.

Original number assigned to reference is used when it is cited again.

#### Hypoxia during drowning and near-drowning incidents

The major physiological problem facing drowning victims is hypoxia, or lack of adequate oxygen perfusion to body cells.<sup>1,4</sup> Hypoxia results in damage to many organs, including the heart, lungs, kidneys, liver, and intestines.<sup>4</sup> Generally, the length of time the body has been deprived of oxygen is closely related to patient prognosis. Only 6-7 s of hypoxia may cause unconsciousness; if hypoxia lasts longer than 5 min at relatively warm temperatures, death or irreversible brain damage may result.<sup>5</sup> However, some victims of immersion in cold water have survived after periods of oxygen deprivation lasting up to two hours.<sup>4</sup> . . .

#### CONCLUSIONS

Recent research on cold-water immersion incidents has provided a more complete understanding of the physiological processes

Conclusion provides suggestions for future research and links to broader issues.

Acknowledgments thank those who assisted with paper.

#### Hypothermia and Diving Reflex 4

occurring during drowning and near-drowning accidents. Current findings suggest that the cooperative effect of the mammalian diving reflex and hypothermia plays a critical role in patient survival during a cold-water immersion incident. However, the relationship between the two processes is still unclear. Because it is impossible to provide an exact reproduction of a particular drowning incident within the laboratory, research is hampered by the lack of complete details surrounding drowning incidents. Consequently, it is difficult for comparisons to be drawn between published case studies. More complete and accurate documentation of cold-water immersion incidents--including time of submersion; time of recovery; and a profile of the victim including age, sex, physical condition--will facilitate easier comparison of individual situations and lead to a more complete knowledge of the processes affecting long-term survival rates for drowning victims. Once we have a clearer understanding of the relationship between hypothermia and the mammalian diving reflex, and of the effect of such factors as the age of the victim, physicians and rescue personnel can take steps to improve patient care both at the scene and in the hospital.

#### ACKNOWLEDGMENTS

I would like to thank V. McMillan and D. Huerta for their support, suggestions, and patience throughout the production of this paper. I am also grateful to my classmates in COMP 281, for their thoughtful comments during writing workshops. Finally, I thank

## Hypothermia and Diving Reflex 5

Colgate's interlibrary loan staff for their tireless efforts to secure the sources I needed for this paper.

References, listed numerically, correspond to callouts in text, following the CBE documentation style.

### REFERENCES

1. Kallas HJ, O'Rourke PP. Drowning and immersion injuries in children. *Curr Opin Pediatr* 1993;5:295-302.
2. Keatinge WR. Accidental immersion hypothermia and drowning. *Practitioner* 1977;219:183-7.
3. Gooden BA. Why some people do not drown-hypothermia versus the diving response. *Med J Aust* 1992;157:629-32.
4. Biggart MJ, Bohn DJ. Effect of hypothermia and cardiac arrest on outcome of near drowning accidents in children. *J Pediatr* 1990;117:179-83.
5. Gooden BA. Drowning and the diving reflex in man. *Med J Aust* 1972;2:583-7.
6. Bierens JJ, van der Velde EA. Submersion in the Netherlands: Prognostic indicators and the results of resuscitation. *Ann Emerg Med* 1990;19(12):1390-5.
7. Ramey CA, Ramey DN, Hayward JS. Dive response of children in relation to cold-water near drowning. *J Appl Physiol* 1987;62(2):665-8.
8. Wong KC. Physiology and pharmacology of hypothermia. *West J Med* 1983;138(2):227-32.
9. Kamp AM and Sibert JR. Outcome in children who nearly drown--a British Isles study. *Br Med J* 1991;301:931-3.

Hypothermia and Diving Reflex 6

10. Conn AW, Edmonds JF, Barker GA. Cerebral resuscitation in near drowning. *Pediat Clin North Am* 1979;26(3):691-701.