

## Impact case study (REF3b)

<p><b>Institution:</b> University of Portsmouth</p>
<p><b>Unit of Assessment:</b> 26 Sport and Exercise Sciences, Leisure and Tourism</p>
<p><b>Title of case study:</b> Improving understanding and changing protocols for the rescue and resuscitation of immersion victims.</p>
<p><b>1. Summary of the impact</b>  Internationally, immersion is a leading cause of accidental death and <i>the</i> leading cause of death of sportspeople (221 of the 635 UK immersion deaths in 2012 were sports-related). The Extreme Environmental Medicine &amp; Science Research Group (EEMSRG) publishes widely, from scientific papers to specific reports for a wide range of international end-users, including various emergency services. Our research has had global impact on (i) The protection, rescue and treatment of immersion casualties, (ii) International standards, guidelines, policies, campaigns and training manuals of those responsible for the protection, rescue and resuscitation of casualties, (iii) Raised public awareness of immersion issues.</p>
<p><b>2. Underpinning research</b>  The research underpinning this ICS was led by Professor Tipton, with contributions from Dr Eglin (Principal lecturer); both appointed in 1998. More recently Dr Lunt has contributed (appointed as lecturer in 2013 after completing PhD and post-doctoral studies within EEMSRG). Dr (Admiral) Frank Golden OBE has acted as medical consultant to the group, which investigates the fundamental and applied aspects of the pathophysiological and physiological responses to immersion.</p> <p>The WHO estimates 1.2 million people drown each year; drowning kills more children than Malaria, TB, HiV or Polio. In the UK, one child drowns each week on average. Tipton highlighted the role of the initial cardio-respiratory responses to cold water immersion (“Cold Shock”) as a precursor to drowning and thereby changed the priority for risk assessment and therapy from hypothermia to drowning, and the emphasis on protection to include the provision of emergency underwater breathing aids (EBA). Subsequent applied R&amp;D work produced the first EBA for helicopter passengers (“Air Pocket”) and a methodology for the standardised assessment of EBA (Barwood et al, 2010). The group described “Circum-rescue collapse” for the first time, with consequences for the way immersion casualties are rescued. The group also characterised the progression towards swim failure in cold water, assisting its identification and prevention (1).</p> <p>Since establishing the EEMSRG in 1999 Tipton and colleagues have proposed fundamental mechanisms to explain sudden death and prolonged survival underwater (2 &amp; Tipton 2003, Lancet). Again, and importantly, the applied implications of these findings for the search, rescue and resuscitation of submerged casualties were developed by meta-analysis and consensus meetings into a decision making guide to assist the search and rescue community (4). With the aim of making search and rescue policies as realistic as possible, the ability to undertake basic life support on small boats has also been studied (3). In addition to looking at technology-based protection against cold (EBA, specialist clothing), the EEMSRG have undertaken a detailed examination of habituation to cold, as well as studied the novel concept of “cross-adaptation” between cold immersion and altitude (Lunt et al, 2012).</p> <p>Recent work has included a new theory for sudden cardiac death on immersion and in other circumstances. “Autonomic Conflict” occurs when the two branches of the autonomic nervous system are co-activated (Tipton et al, 2010). The proposed mechanism underlying Autonomic Conflict has been investigated by a combination of human and isolated heart studies (5). Consistent with the EEMSRG’s approach of ensuring that the relevance and application of fundamental work is communicated to those who may be most impacted, additional applied research work and papers have been produced in the areas of helicopter underwater escape training (Tipton et al, 2010) and open water sporting events (6). This work is already having an impact on the interpretation of immersion-related deaths and the planning of sporting events. Much of the applied output of the EEMSRG is through scientific reports directly to specific agencies; it is</p>

by this route that the most direct impact occurs; we have published 58 such reports since 2008.

### 3. References to the research

1. Tipton MJ, Franks CM, Gennser M & Golden FStC (1999) Immersion death and deterioration in swimming performance in cold water. *The Lancet* Vol 354 (Fast track) 21 Aug, No. 9179: 626-9. ISSN 0140-6736 [10.1016/S0140-6736\(99\)07273-6](https://doi.org/10.1016/S0140-6736(99)07273-6).  
*This paper was the first to provide a detailed characterisation of swim failure in humans. Its findings and figures have been reproduced in many publications on water safety.* Impact Factor: 39.06.
2. Datta, A. & Tipton, M. J. (2006) Respiratory responses to cold water immersion: neural pathways, interactions and clinical consequences. *Journal of Applied Physiology*. 100(6): 2057-2064. ISSN 8750-7587 [10.1152/jappphysiol.01201.2005](https://doi.org/10.1152/jappphysiol.01201.2005).  
*This paper was the first to describe the central neural pathways and cerebral blood flow changes associated with "Cold Shock" and the possible neuro-anatomical correlate of what was subsequently called "Autonomic Conflict" (AC), as well as the association of AC with survival on immersion, during birth and sleep, and the implications of AC for sudden death in other circumstances.* Impact Factor: 3.75.
3. Tipton MJ, David G, Eglin CM & Golden FStC (2007) Basic life support on small boats at sea. *Resuscitation* 75(2): 332-337. ISSN 0300 9572 [10.1016/j.resuscitation.2007.04.027](https://doi.org/10.1016/j.resuscitation.2007.04.027).  
*This was the first paper to measure the ability to perform basic life support at sea on small boats. It helped inform the safety cover policy for oil companies operating in the North Sea and elsewhere.* Impact Factor: 4.104.
4. Tipton MJ & Golden FStC (2011) A proposed decision-making guide for the search, rescue and resuscitation of submersion [head under] victims based on expert opinion. *Resuscitation*. 82(7):819-24. ISSN 0300-9572 [10.1016/j.resuscitation.2011.02.021](https://doi.org/10.1016/j.resuscitation.2011.02.021).  
*This paper provided the first evidence-base for helping to determine search and rescue times for submerged casualties. The resulting guidance is already being used by the Fire & Rescue Service (FRS, National Operational Guidance, Water Rescue & Flooding) and has been the catalyst that is aligning the immersion rescue and resuscitation protocols of the RNLI, FRS, Ambulance service, Resuscitation Council and SARUK.* Impact Factor: 4.104.  
 Ref2 output: 26-MT-002
5. Shattock MJ, Tipton MJ (2012) "Autonomic conflict": a different way to die during cold water immersion? *J Physiol*. 15; 590(Pt 14): 3219-30. ISSN 0022-751 DOI: [10.1113/jphysiol.2012.229864](https://doi.org/10.1113/jphysiol.2012.229864).  
*On the basis of original human & animal work, this was first paper to fully elucidate our theory of Autonomic conflict with human and animal supporting data. The evidence from different meetings and websites is that it is changing the way sudden death, particularly on immersion, is being regarded. This work won "Best paper" at the 2011 World Congress on Drowning Prevention and the theory has already been incorporated into: the ILS position statement on cold water immersion; the Oxford handbook of Expedition and Wilderness Medicine; and Caroline's Textbook of Emergency Care.* Impact Factor: 4.834.  
 Ref2 output: 26-MT-004
6. Tipton, M. J. (2013) Sudden cardiac death during open water swimming. *British Journal of Sports Medicine*. Online First, published on February 1. ISSN 0306-3674 [10.1136/bjsports-](https://doi.org/10.1136/bjsports-)

[2012-092021](#)

*This paper contextualises our theory of Autonomic Conflict for the sporting population; in particular it proposes a theory for death during open water swimming (79% of deaths during triathlon occur during the swim). It is already changing the way open water sporting events are organised. Impact Factor: 3.668.*

#### 4. Details of the impact

Research in the department's Extreme Environments Laboratory (EEL) by the EEMSRG has had profound, global and paradigm-altering significance within the REF period.

**a. Impact on the protection, rescue and treatment of immersion casualties.** The EEMSRG introduced the concepts of "Cold Shock", "Circum-rescue collapse" and "Autonomic conflict"; these major advances in the understanding of the physiological response to immersion have directly informed the protection (equipment provided), rescue (methods) and treatment (priorities) of immersion casualties: "*Dr Tipton's elucidation of cold water shock has transformed the physiologic understanding of drowning.*" (1). "*The work of the laboratory has significantly influenced our thinking and understanding of the hazardous responses to immersion and ... our policies for the search, rescue and treatment of immersion casualties*" (2). EEMSRGs work is regularly used in fatal accident enquiries and legal cases, ranging from child abuse to murder, informing decisions and recommendations (3, 4).

**b. Impact on International standards, guidelines, training manuals.** The premier organisation for establishing international standards in sea survival is the UN's International Maritime Organisation (173 member nations). Its "A Pocket Guide to Cold Water Survival", was "*largely based on the work of the EEL (EEMSRG)*" (5). Published in 2012, it sold in excess of 10,000 copies in the first three months. This publication forms the basis of the immersion survival, protection and search and rescue policies of member states.

EEMSRG research has informed the training programmes of numerous international organisations including the International Lifesaving Federation, the world authority for drowning prevention, lifesaving and lifesaving sport. Our work has "*influenced the development of international lifesaving programmes and standards*" and "*a number of the ILS International Lifesaving Certificates have standards based on evidence arising from the University of Portsmouth*" (6). The work of the EEMSRG appears in many first aid and search and rescue training manuals, including those of: the Royal National Lifeboat Institution (RNLI), Royal Yachting Association (RYA), Mountain Rescue; Surf Lifesaving GB and New Zealand; Moroccan SAR; Royal Netherlands SAR; US Lifesaving Association; UK and Canadian military SAR; Yachting Australia. "*The research work (of the EEMSRG) has produced the science to base our current casualty care syllabus, teaching and practice upon in the fields of immersion, submersion and hypothermia*" (7, 8).

Recent research on "Autonomic Conflict" (2012, Section 3, Reference 5) is already described in the first aid manuals and training material of Surf Lifesaving GB and the RNLI. Our recent publication "A proposed decision-making guide for the search, rescue and resuscitation of submersion (head under) victims based on expert opinion" is being used internationally. In the UK it has been the catalyst to move the different SAR agencies towards using a common operational protocol: "*Portsmouth University influenced our thinking, assisted and supported the development of National Guidance*" (8, 9). Our work appears verbatim in the Fire & Rescue Services National Operational Guidance on Water Rescue and Flooding. Recent research on survival time during head-out immersion has been used by the US Coastguard to produce new search and rescue models and strategy.

**c. Impact on public awareness.** An important method for reducing the number of annual immersion deaths involves educating the public about the risks of cold immersion. This form of "preventative medicine" has been achieved through involvement with various agencies noted above; helping them produce campaigns for lifejacket usage e.g. "Useless unless worn" (UK: RNLI, HMCoastguard); "Stay on top with a lifejacket" (Maritime New Zealand); "Wear one for openers"

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(Maritime Australia). We have also been involved in water safety campaigns (e.g. RNLI “Respect Water” campaign August 2013) and appeared in, and helped write the script for the RNLI water safety video “Cold Shock” (2010), as well as taught on RNLI, RoSPA and RYA sea survival courses. Between 2008 and 2012 EEMSRG staff were involved in over 100 media appearances demonstrating and discussing the risks of immersion. Tipton also lectures on immersion and drowning to medical students in London, Leeds and Birmingham.

It would be nice to think that the impact outlined above has saved lives. This is difficult to determine definitively, however it is encouraging to hear from those that should know that this is the case: “There is little doubt that the work the (EEMSRG) does in the field of cold water survival continues to save lives every year (10); “Without doubt the excellent work carried out by (EEMSRG) has contributed significantly to our goal of saving lives at sea” (7); “The work of the EEMSRG has undoubtedly saved the lives of immersion casualties” (8). “This has been literally lifesaving work. Thank you” (2).

### 5. Sources to corroborate the impact

1. Letter: Professor of Paediatrics, Paediatric Emergency Medicine, Seattle Children’s hospital and University of Washington School of Medicine, Seattle, USA.
2. Letter: Head of Intensive Care del Centro del Hospital Municipal Miguel Couto, Rio de Janeiro; Medical Center recuperación del Ahogados of Barra de Tijuca, Cuerpo de Bomberos, Rio de Janeiro; Medical Director SOBRASA Sociedade Brasileira de Salvamento Aquatico, Brasil.
3. Letter: Chief Medical Adviser, Royal Life Saving Society UK; Honorary Medical Adviser ILSE; Honorary Secretary, Medical Committee ILS; Honorary Consultant Physician & Cardiologist, Colchester General Hospital, England; Immediate Past Co-Chairman of the Basic Life Support Task Force of the International Liaison Committee on Resuscitation (ILCOR). Member of the European Resuscitation Council (ERC) BLS Task Force in ILCOR, and is Chairman of the ERC International BLS Course Committee. Past Chairman of the Resuscitation Council (UK) and currently Chairman of their BLS/AED Subcommittee.
4. Letter: Deputy Chief Inspector of Marine Accidents, Marine Accident Investigation Branch, Southampton.
5. Letter: Secretary, International Maritime Rescue Federation, Stonehaven, UK.
6. Letter: Chairman, International Lifesaving Federation Business Commission, Belgium.
7. Letter: Chairman, RNLI Medical & Survival Committee; Consultant in cardiothoracic anaesthesiology at Southampton University; Medical Director for South Central Ambulance Service (Hampshire); Author of UK Resuscitation Council courses for Advanced Life Support; Co-chair of the Advanced Life Support Group of the International Liaison Committee on Resuscitation.
8. Letter: Medical & Technical Consultants to Surf Lifesaving GB.
9. Letter: Medical Director, National Ambulance Resilience Unit, West Midlands; Associate Medical Director at East Midlands Ambulance Service NHS Trust.
10. Letter: Royal Yachting Association Training Manager and Chief Examiner.