

<b>Institution:</b> University of Portsmouth		
<b>Unit of Assessment:</b> UoA24: Sport and Exercise Sciences, Leisure and Tourism		
<b>Title of case study:</b> Improving water safety: informing international and UK policies, changing behaviour and practice, and saving lives		
<b>Period when the underpinning research was undertaken:</b> 2008 - 2018		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Michael Tipton	Professor	01/04/1998 - date
Heather Massey (née Lunt)	Senior Lecturer	01/10/2010 - date
Jo Corbett	Associate Head (Research)	19/09/2005 - date
Gemma Milligan	Senior Lecturer	25/03/2008 - date
Jim House	Reader in Environmental Physiology	01/05/2008 - 21/11/2018
Martin Barwood	Senior Lecturer	01/09/2007 - 31/07/2013
<b>Period when the claimed impact occurred:</b> 01 August 2013 - 31 July 2020		
<b>Is this case study continued from a case study submitted in 2014?</b> N		
<b>1. Summary of the impact</b>		
<p>Drowning is the third most common cause of accidental death worldwide, accounting for around 320,000 deaths annually (World Health Organization, 2020) and around 200 deaths during sport and leisure activities each year in the UK (Water Incident Database). Original research from the University of Portsmouth (UoP) underpins 'Respect the Water', a national water-safety campaign that has increased awareness of the dangers of cold water, changed water-safety behaviour and saved the lives of children and adults. Our research underpins water-safety training delivered to over 100,000 children across the UK, has been incorporated into the practice, policies and recommendations of national and international water-safety organisations, and has changed UK legislation for lifejacket usage, preventing the deaths of fisherman. We have increased understanding of the causes of drowning-related deaths, informed medical guidelines for treating immersion casualties and underpinned UK, US and international Search and Rescue guidelines that are used in 162 countries by 99% of the world's merchant shipping.</p>		
<b>2. Underpinning research</b>		
<p>The outputs underpinning this case study were led by <b>Professor Michael Tipton</b>, in conjunction with other members of the Extreme Environments Group (EEG) at UoP. These outputs represent a significant body of water-safety research, founded on the city's maritime and naval heritage, and undertaken with input from relevant stakeholders and collaborators. The research intersects at each stage of the drowning timeline, a model of the stages of the drowning process (<i>Am J Emerg Med.</i> 2016, 34(11): 2224-2226), developed by <b>Tipton</b> in collaboration with the International Drowning Research Alliance ([IDRA] <a href="http://idra.world/">http://idra.world/</a>).</p> <p>(<b>R1</b>, <b>R2</b> and <b>R3</b>) are examples of our research examining the 'cold shock' response, a series of physiological responses evoked by immersion in cold water, characterised by an 'inspiratory gasp', hyperventilation, elevated heart rate, and peripheral vasoconstriction. These responses are temporarily debilitating and can be life threatening; they are implicated in sudden death on initial immersion and the observation that 40% of drownings occur within 2m of safety (International Lifesaving Federation, 2010). Building on <b>Tipton's</b> earlier work on cold shock, the EEG undertook a series of studies investigating the role of anxiety and threat appraisal on cold shock (for a summary see: <i>Front Psychol.</i> 2018, 11; 9: 510). (<b>R1</b>), which is a representative example from this body of work, investigated the effect of elevated anxiety, induced through a deception manipulation, on the cold shock response in adults. The research demonstrated that, compared to a non-deception control, anxiety increased the magnitude of the cold shock response upon cold water immersion. (<b>R2</b>), conducted in collaboration with colleagues from King's College London, demonstrated that the simultaneous activation of parasympathetic and sympathetic autonomic inputs to the heart, which may occur during cold-water submersion, increased arrhythmias in an animal model with long QT syndrome (a heritable condition linked to sudden cardiac death). This supported our 'autonomic conflict' hypothesis for explaining sudden death during cold-water immersion (<i>J Physiol.</i> 2012, 15; 590(14): 3219-3230), and together with (<b>R1</b>), provided empirical evidence for safety strategies that minimise anxiety upon cold-water immersion. (<b>R3</b>) examined</p>		

the physiological responses of children undergoing cold-water immersion, providing the first published evidence of the cold shock response in children. This indicated that safety behaviours to mitigate cold shock would be relevant for children, as well as adults.

Given the debilitating effects of cold shock, the actions taken before and during the initial minutes of immersion are critical in determining survival. (R4), funded by the Royal Society for the Prevention of Accidents (G1), investigated the buoyancy of different clothing assemblies upon immersion in water, when floating and swimming. In a series of laboratory and field trials with adults, adolescents and children, it was demonstrated that clothing layers significantly improved buoyancy and airway freeboard (mouth to water distance) on immersion. This supported our recommendation that the primary survival behaviour for adults and children upon accidental immersion should be to 'float first', until the cold shock response is reduced. (R5), funded by Royal National Lifeboat Institution (RNLI; G2, G3), examined the effect of a crotch-strap retention system on lifejacket performance; reference to lifejackets 'riding up' over the torso and head was evident in a number of fatal accident reports. Lifejacket performance was assessed following a vertical water entry and in 3-hour exposures to waves using a custom-built 'drowning manikin', to estimate the time taken to inhale the lethal seawater dose. Compared to a no crotch-strap condition, airway freeboard was greater with a crotch-strap and the time taken to aspirate the lethal dose of seawater for drowning doubled, indicating improved airway protection.

Once an individual becomes immersed in water, rescuers must be able to accurately estimate survival time to coordinate rescue efforts and, subsequently, to review the incident to prevent future occurrence. (R6), undertaken in collaboration with the Maritime and Coastguard Agency, details a retrospective analysis of fatal maritime incident data collected between 2007 and 2016. The research identified that 180 lives (47% of all cases) could have been saved if a lifejacket had been worn and provided empirical support for the use of lifejackets. (R7), funded by the US Coast Guard (G4), used data from the UK National Immersion Incident Survey to model survival capability for immersion victims. This is the largest database of its kind and includes information about the physical attributes of the immersion victim, environmental conditions, duration of immersion, and survival. From these data, the most significant factors determining cold-water immersion survivability were identified and a mathematical model was produced to predict survival time in cold water.

### 3. References to the research

#### 3.1 Research outputs

- R1. **Barwood, M. J., Corbett, J.,** Green, R., Smith, T., Tomlin, P., Weir-Blankenstein, L., & **Tipton M. J.** (2013). Acute anxiety increases the magnitude of the cold shock response before and after habituation. *European Journal of Applied Physiology*, 113(3), 681-689. <https://doi.org/10.1007/s00421-012-2473-y>
- R2. Winter, J., **Tipton, M. J.,** & Shattock, M. J. (2018). Autonomic conflict exacerbates long QT associated ventricular arrhythmias. *Journal of Molecular and Cellular Cardiology*, 116, 145-154. <https://doi.org/10.1016/j.yjmcc.2018.02.001>
- R3. Bird, F., **House, J.,** & **Tipton, M. J.** (2015). The physiological response on immersion in cold water and cooling rates during swimming in a group of children aged 10–11 years. *International Journal of Aquatic Research and Education*, 9(2), 162-174. <https://doi.org/10.25035/ijare.09.02.07>
- R4. **Barwood, M. J.,** Bates, V., Long, G. M., & **Tipton, M. J.** (2011). "Float first": trapped air between clothing layers significantly improves buoyancy on water after immersion. *International Journal of Aquatic Research and Education*, 5(2), 147-163. <https://doi.org/10.25035/ijare.05.02.03>
- R5. **Lunt, H.,** White, D., Long, G., & **Tipton, M.** (2014). Wearing a crotch strap on a correctly fitted lifejacket improves lifejacket performance. *Ergonomics*, 57(8), 1256-1264. <https://doi.org/10.1080/00140139.2014.914579>
- R6. Pointer, K., **Milligan, G. S.,** Garratt, K. L., Clark, S. P., & **Tipton, M. J.** (2018). A 10-year descriptive analysis of UK Maritime and Coastguard data on lifejacket use and drowning prevention. *Safety Science*, 109, 195-200. <https://doi.org/10.1016/j.ssci.2018.06.003>

R7. **Tipton, M.**, McCormack, E., & Turner, C. (2014). International Data Registration for Accidental and Immersion Hypothermia: The UK National Immersion Incident Survey – Revisited. In J. J. L. M. Bierens (Ed.), *Drowning: prevention, rescue, treatment* (pp. 921-922). Berlin: Springer. [https://doi.org/10.1007/978-3-642-04253-9\\_142](https://doi.org/10.1007/978-3-642-04253-9_142)

### 3.2 Evidence of the quality of the research

These outputs are a representative selection of a substantial body of related work. All employ robust design, appropriate research techniques and are published in peer-reviewed academic journals or reference texts relevant to their field. The quality of this work is further supported by **Tipton** receiving the Member of the Order of the British Empire (2018) and the Ireland Medal (2019) for his research on water safety and drowning prevention.

### 3.3 Related grants

G1. **Barwood, M. J.**, & **Tipton, M. J.** *ROSPA BNFL Scholarship Scheme*. Funded by The Royal Society for the Prevention of Accidents, 01/10/09 → 30/04/10, (GBP19,833)

G2. **Tipton, M. J.** *Reviewing of the pros and cons associated with the use of crotch straps on lifejackets*. Funded by the Royal National Lifeboat Institution, 27/02/12 → 10/04/12, (GBP9,582)

G3. **Tipton, M. J.**, & **Massey, H. C.** *The impact of 'riding-up' on lifejacket performance*. Funded by the Royal National Lifeboat Institution, 01/11/12 → 28/06/13, (GBP59,890)

G4. **Tipton, M. J.** *Investigation of the UK National Immersion Incident Survey*. Funded by the US Coast Guard, 2008, (GBP8,000).

## 4. Details of the impact

'Respect the Water' is a nationwide, multimedia, water-safety campaign launched in 2014 by the RNLI with the aim of reducing drowning deaths in the UK and Ireland. Throughout this campaign, **Tipton** has acted as scientific advisor to the RNLI and been a member of the RNLI Council and Medical Committee. He has appeared in campaign material, given radio and television interviews in support of the campaign, and undertaken a 24hr Ask Me Anything on cold-water survival on the online platform Reddit (19/12/2017); a substantial amount of campaign footage was filmed in the UoP's Extreme Environments Laboratory. **The initial campaign theme 'Treat the water with respect, not everyone can be saved' was underpinned by our research on cold shock (R1-3, S1)**. Between 2014 and 2016, the campaign discouraged cold water entry by highlighting the physiological incapacitation and negative physiological consequences of the cold shock response (**R1-3**), the risks arising from reduced breath-hold time (**R1, R3**), and the effect of anxiety on this response (**R1, R2**). However, recognising that just under 50% of those who enter cold water do so unintentionally, the campaign message shifted in 2017 to mitigate the impact of cold shock, instructing people to 'Fight your instincts', relax and 'Float to Live' until breathing is back under conscious control (**S1**). **This safety advice was directly underpinned by our research demonstrating the buoyancy provided by trapped air between clothing layers**, and advocated floating ('float first') as the primary survival behaviour upon accidental water immersion (**R4**). The direct link between our research and the water safety advice underpinning this campaign is typified by the information on the campaign website (<https://www.respectthewater.com/>). This includes a video presented by **Tipton** describing cold shock and how to overcome this ('how to survive cold water shock'), a 'Floating Facts' section, referencing our research (**R4**) and including floating instructions, a 3D interactive graphic, and a video on how to float if immersed (**S1**).

The reach of 'Respect the Water' has been substantial. In the first month of the 2017 campaign, 5,700,000 males (a target demographic accounting for more than 90% of coastal drownings) were reached through social-media. In 2018, 535 items of print and broadcast media reached 46,000,000 people (**S2**), 266,000 people visited the campaign website and **more than 50% of young men in the UK were aware of 'Respect the Water' (S2)**. The 'Float to Live' YouTube video (<https://www.youtube.com/watch?v=jncVb2onYC4>), underpinned by our work, has received over 13,000,000 views, with a 'Cold Shock' video featuring Tipton viewed over 79,000 times (<https://www.youtube.com/watch?v=tRRluH7Cp78>). The significance of 'Respect the Water' has been pronounced, resulting in increased awareness and understanding of water safety, behavioural changes, and saved lives. RNLI data following the 2018 campaign demonstrated that the proportion of young men in the UK taking precautions near the water rose from 77% to 87%, with a significant increase in the number saying that they would 'float first' if accidentally immersed.

Across the 2017 to 2019 campaigns, **22 individuals contacted the RNLI to say that the 'Float to Live' technique saved their life (S2)**. This is exemplified by testimony provided by an individual who used 'Float to Live' advice in a survival situation: *'I panicked for a few seconds and that's when I remembered the radio commercial that told me to float instead of fighting the water. I just lay back and started floating and kicking my legs... It saved my life.'* (S3). More recently (July 2020), the impact of our work was evidenced in the statements of an RNLI coxswain after rescuing a 10 year old boy who was found floating with arms and legs spread, half a mile from shore *'...he'd been watching lifeboat rescues on 'Saving lives at Sea' (BBC television programme) and followed the advice given on the show ...had he not, the outcome might have been very different'* (S3).

According to the UK Water Incident Database, approximately 40 young people drown in the UK every year. The 'Swim Safe' programme, delivered by Swim England and the RNLI, has run annually between May and September since 2013. This programme teaches children aged 7-14 how to be safe in, and around, open water. It has now **been delivered to over 100,000 children** and includes information on 'cold shock' (R3), advocates 'float first' as a primary safety behaviour and provides practical floating tuition (R4). An independent evaluation indicates that this **has been effective at improving children's water safety knowledge**. For example, before 'Swim Safe', only 38% knew that the cold water makes it difficult to breathe normally; this rose to 69% after the programme (S4). The RNLI have also produced a range of free educational resources (<https://rnli.org/youth-education/education-resources>) for delivery in schools, including lesson plans, posters, and videos on 'cold shock' and 'Float to Live', tailored for Key Stages 1-4. These were all reviewed and approved by **Tipton**. At a local level, in 2019, **Tipton**, in partnership with Hampshire County Council and the RNLI, developed 'Stay Afloat', a free, downloadable, water safety education resource pack underpinned by our water-safety research (R1-4) for Key Stage 3 and 4 children across Hampshire (<https://www.hants.gov.uk/educationandlearning/stayafloat>). This has been delivered in Hampshire schools, with our own research on more than 1,000 children demonstrating significantly increased awareness of the dangers of cold-water shock and the appropriate behaviours to take if immersed, which was retained 3-6 months later.

Our research (R4) also underpins the **Royal Life Saving Society's Water Safety Code (S5)** and has been incorporated into the **Royal Society for the Prevention of Accidents guidance for Managing Safety at Inland Waters (R1-4, S6)**. 'Float first' is now recommended by the **UK Coastguard** to 999 callers for maritime in-water incidents, and internationally, by the **Alaska Office of Boating Safety**, a US Government Department. Our body of water safety research has also been utilised in the 2015 **European Resuscitation Council Guidelines for Resuscitation**, the 2016 **Wilderness Medical Society Practice Guidelines for the Prevention and Treatment of Drowning**, and the **International Liaison Committee On Resuscitation's 2015 Advisory Statement on Guidelines for Reporting of Data of Drowning Related Resuscitation**. A 2019 podcast (Drowning: Roadside to Rescue) produced by 'The Resus Room', a medical education site focusing on patient care in and around the resuscitation room, was based on our water safety research and listened to by more than 17,000 people within the first 5 months.

Based on (R5), **the use of crotch straps on lifejackets is now recommended in the UK by the RNLI (S7)**, as well as internationally by the **New Zealand Coastguard (S8)**, who advocate their use to improve lifejacket function. (R6), demonstrating the number of lives that would have been saved if individuals had been wearing lifejackets, was undertaken by the Maritime and Coastguard Agency Casualty Review Panel, which **Tipton** is a member of. This research **underpins the Maritime and Coastguard Agency Marine Guidance Note (MGN) 588 (S9)**. This legislation, published in 2018, mandates that all UK fishermen on fishing vessels must be provided with, and wear, personal floatation devices, unless measures are in place which eliminate the risk of falling overboard. **This applies to approximately 12,000 UK commercial fisherman** and, based upon estimates of the number of deaths per year among commercial fishermen that would probably or possibly have been prevented with lifejacket use (R6), **will save 2-4 lives per annum. (R6)**, as well as the 'Respect the Water' Campaign, underpinned by our research (R1-4), are referenced in the **National Water Safety Forum's UK National Drowning Prevention Strategy (2016-2020)**, where they highlight the need for improved understanding of water safety behaviour and demonstrate how the UK is increasing awareness of risks around water (S10). This National Strategy was produced in response to a World Health Organization report recommending that



every country has a water safety strategy, and launched at the House of Commons in 2016 by the Minister of State for Transport. In 2019, the National Water Safety Forum stated that they were '*cautiously optimistic*' that the Strategy was being effective and '*the overall reduction over the three years is a good indicator that our efforts are paying off and fewer people and families are affected by drowning*'.

Finally, our research modelling survival times in cold water (R7) has been incorporated into the 2019 **UK Department for Environment, Food and Rural Affairs (DEFRA) Flood Rescue Concept of Operations** (<https://www.gov.uk/government/publications/flood-rescue-concept-of-operations-2019> pg. 42) and underpins the survivability model within the **UK Fire and Rescue Service National Operational Guidance on Rescue from Water** (<https://www.ukfrs.com/scenarios/rescue-water>), guiding the time and resources devoted when searching for individuals immersed in cold water. Internationally, within the **United States Coast Guard (USCG)**, our survival prediction research has '*provided critical input into the ACTSUS (Active Search Suspended Pending Further Developments) decision making process*' (S11). The significance of this work is profound because **the ACTSUS decision determines the resource to be allocated and the point at which search is suspended by the search and rescue planner (S11)**; this '*represents a critical juncture for the victim, their families, and the USCG*' that is '*tantamount to declaring the victim dead using only circumstantial evidence*' (S11). The reach of this work is substantial; the USCG has 22 million square miles of responsibility and undertakes 20,000 search and rescue cases each year. Moreover, (R7) is also included in the **International Aeronautical and Maritime Search and Rescue Manual (Vol 3)**, published by two **United Nations organisations** (International Maritime Organisation; International Civil Aviation Authority) to provide a common aviation and maritime approach to search and rescue provision (S12). According to the International Safety of Life at Sea (SOLAS) regulations, all ships are required to carry this publication for use in search and rescue; **this applies to 162 signatory countries, incorporating 99% of the world's merchant ships by tonnage.**

#### 5. Sources to corroborate the impact

S1. RNLI Respect the Water campaign information: a) exemplar 2016 campaign material (pg.1-4); b) 2017 campaign guide (pg. 5-12); c) website <https://www.respectthewater.com/> accessed 6.8.2020 (pg. 13-30)

S2. RNLI Annual reports and accounts, 2017-2019

S3. Respect the Water testimonials: a) survivor testimonial: <https://www.respectthewater.com/survivors/> accessed 6.8.2020; b) RNLI coxswain testimonial: <https://www.bbc.co.uk/news/uk-england-york-north-yorkshire-53637025> accessed 3.8.2020.

S4. Independent evaluation of 2016 Swim Safe programme (short report), undertaken by Sport Structures on behalf of the RNLI, January 2017, pg. 6.

S5. Royal Life Saving Society Water Safety Code

S6. Royal Society for the Prevention of Accidents guidance for Managing Safety at Inland Waters, 2018, pg. 72.

S7. Choose it wear it: The RNLI guide to lifejackets and buoyancy aids, 2016, pg.13.

S8. Safe Boating Tips from Coastguard New Zealand: The importance of crotch straps. Boating New Zealand, October 2018, pg. 108-109.

S9. Maritime and Coastguard Agency, Marine Guidance Note (MGN) 588 (2018)

S10. National Water Safety Forum (2015) A future without drowning: The UK National Drowning Prevention Strategy 2016-2026

S11. Testimonial from Oceanographer, Office of Search and Rescue, US Coast Guard, 31/08/2020

S12. International Aeronautical and Maritime Search and Rescue Manual Volume III - Mobile Facilities (2016) 10<sup>th</sup> edition, pg. 143.