

2-1-2019

Triennial Scientific Review: Assisting Drowning Victims: Effective Water Rescue Equipment for Lay-responders

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Recommended Citation

Beale-Tawfeeq, Angela K. (2019) "Triennial Scientific Review: Assisting Drowning Victims: Effective Water Rescue Equipment for Lay-responders," *International Journal of Aquatic Research and Education*: Vol. 10 : No. 4 , Article 8.

DOI: <https://doi.org/10.25035/ijare.10.04.08>

Available at: <https://scholarworks.bgsu.edu/ijare/vol10/iss4/8>

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Triennial Scientific Review: Assisting Drowning Victims: Effective Water Rescue Equipment for Lay-responders

Cover Page Footnote

Thanks to members of the aquatic sub-council of the American Red Cross Scientific Advisory Council who provided feedback and editing on this scientific review.

Abstract

The original question addressed in the scientific review was *What is the most effective piece of rescue equipment for a lay responder to throw to a person in trouble in water?* and the modified question was rephrased as *What are the most effective types of aquatic rescue equipment for a layperson/bystander to use to rescue a drowning person?* To thoroughly analyze the main question, the following sub-questions were examined: *What are the most accurate and buoyant types of devices? What specific equipment is best for quick rescues? What specific equipment can be grasped most easily by drowning victims?* This research topic is a valid area of inquiry because drowning is a serious public health issue which disproportionately impacts diverse populations (e.g., young children (1-4 years of age; adolescents and young adults (ages 15-24 years); minorities (African-Americans, Hispanics/Latinos) (CDC, 2017). Participation in unsupervised recreational aquatic environments remains popular and fairly constant; the need exists to identify the types of aquatic rescue equipment for layperson/bystanders to perform effective rescues. Answering the main question of this review has implications for identifying appropriate pedagogies and educational practices for water safety and learn to swim programs which will be addressed in separate reviews.

Review Process and Literature Search of Evidence Since Last Approval

Key Words. Keywords used for purpose of effective analysis of the literature included aquatic rescue, drowning prevention, water safety, rescue equipment efficacy, layperson/bystander rescue, aiding drowning victims, flotation devices for aiding drowning victims.

Databases. The Scientific Review databases searched included: PubMed, SportDiscus, Physical Education Index, Articles First, First Search, CINAHL Plus with Full Text, Show all ERIC, Health Source-Consumer Edition, Health Source: Nursing/ Academic Edition, MasterFILE Premier, Google Web Search, references from reviewed articles. New literature since last review specifically was the FDA revised recommendations of June 18, 2012.

Websites. The following websites were searched for information on this review.

<https://www.safekids.org/press-release/new-childhood-drowning-study-highlights-surprising-hazards-open-water>

<https://www.ncbi.nlm.nih.gov/pubmed/27633347>

https://www.who.int/violence_injury_prevention/global_report_drowning/Final_report_full_web.pdf

http://www.wcdp2013.org/uploads/media/Prevention8_4_130_Public_Rescue-Equipment_MartinOSullivan.pdf

<http://www.iws.ie/emergency-situations/guidelines-for-the-erection-and-usage-of-ringbuoys.320.html>
http://www.iws.ie/_fileupload/Leaflets/Ringbuoy%20-%20how%20to%20use%20a%20ringbuoy.jpg
<http://www.popularmechanics.co.za/features/when-the-first-responder-is-you/>
<http://faculty.deanza.edu/donahuemary/Howtorescueadrowningvictimusingareachingassistorashepherd'scrook>
<http://www.livescience.com/6866-people-drown.html>
http://www.sobrasa.org/new_sobrasa/arquivos/WCDP_2013/Drowning_chain_all_presentations_all.pdf
<http://instructorcorner.org/welcome/faculty.deanza.edu/.../Howtorescueadrowningvictimusin>
<http://www.watersafe.org.nz/default.asp>
<http://www.aquaticsafetygroup.com/pdf/markelaquaticriskmgmtguide.pdf>
<http://paddling.about.com/od/safetyprecautions/ht/Throw-Bag-Whitewater-Rescue.htm>
<http://survival.about.com/od/13/a/How-To-Rescue-A-Swimmer-With-A-Throw-Bag.htm>
<http://familydoctormag.com/first-aid-and-safety/1311-how-to-save-someone-whos->
[https://www.pediatriccareonline.org/pco/ub/view/Point-of-Care-Quick-Reference/397252/all/Drowning and Near Drowning?q=%22life%20preserver%22](https://www.pediatriccareonline.org/pco/ub/view/Point-of-Care-Quick-Reference/397252/all/Drowning%20and%20Near%20Drowning?q=%22life%20preserver%22)
familydoctormag.com/.../1311-how-to-save-someone-whos-drowning-qr
www.swimmersdaily.com/.../simple-step-by-step-guide-on-how-to-save-s..
<http://lifeguardgdynia.pl/html/bojka.html>,

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Significance of topic. Drowning is a leading cause of deaths worldwide (World Health Organization (WHO) 2014; Legatt & Wilks, 2013) affecting all economies and regions. In the United States, the Centers for Disease Control and Prevention (CDC) (2017) reported:

- An average of 10 people die every day in the U.S. from unintentional drowning-with 1 in 5 of them being children 14 years of age or younger.
- Drowning is the leading cause of injury deaths for children 1-4 years of age. (Centers for Disease Control and Prevention (CDC, 2017)
- Among those 1-14, fatal drowning remains the second-leading cause of unintentional injury-related death behind motor vehicle crashes (CDC, 2017). Drowning is the fifth leading cause of unintentional injury deaths for all ages in the United States (CDC, 2017).

- Participation in formal swim lessons can reduce the likelihood of childhood drowning death by 88% (Brenner et al, 2009).
- Injuries from drowning kill more kids 1-4 years of age than any other cause except birth defects. (Brenner et al, 2009)
- While drowning in swimming pools gets significant attention, the fact is that more children and teens fatally drown in open water. (MacKay, Samuel, & Green, 2018)
- More than 8 in 10 fatal open water drowning victims among children 0-19 years are male.
- The risk also increases with age, with children ages 15-19 years making up nearly half of open water deaths.
- American Indian/ Alaskan Native and Black/African American children fatally drown at higher rates than other races/ethnicities in open water.

Participation in unsupervised recreational aquatic environments (e.g., beaches, rivers, waterfronts) remains popular and constant; at the same time, the “altruistic” desire of laypersons to pursue heroic rescue efforts has led to a documented increase in rescuer-victim drowning deaths (Mecrow, Rahman, Linnan, Scarr, Mashreky, Talab, & Rahman, 2014; Pearn, & Franklin, 2012; Venema, Groothoof, & Bierens, 2010). The need to identify the types of rescue equipment that may enhance the capabilities of laypersons/bystanders to perform effective and safer rescues remains essential (Petross & Blitvich, 2018; O’Sullivan, 2015; Pearn & Franklin, 2009). Published literature related to drowning prevention and the importance of lifeguard supervision, swimming skill, rescue skills and preparation, is abundant. Some studies have shown that needless drowning has occurred because laypersons/bystanders lack knowledge regarding effective types of rescue equipment as well as the knowledge regarding how to execute simple rescue skills (Moran, Webber, & Stanley, 2017). Plentiful research has documented that laypersons/bystanders have the potential to make a critical difference in the survival of persons in trouble in water (Petross & Blitvich, 2018; Moran, Webber, & Stanley, 2017; Szpilman, Løfgren, Webber, Quan, Bierens, Morizot-Leite, & Langendorfer, 2013; Moran & Stanley, 2013; Pearn, & Franklin, 2012; Moran, Quan, Franklin, & Bennett, 2011; Franklin & Pearn, 2011; Venema, Groothoff & Bierens, 2010; Pearn & Franklin, 2009; Michniewicz, Walczuk, & Rostkowska, 2008; Wiesner, 2001; Webber, 2008).

Updated Scientific Foundation. The majority of drowning events each year occur in unguarded locations (United States Lifesaving Association, 2016). The scientific literature lacks research evidence about the effectiveness of water rescue equipment and its use by lay-responders. Little additional scientific evidence has been published since the completion of the original scientific review. The literature review for this triennial review discovered only four new studies that addressed effective rescue equipment use for lay persons/bystanders to assist a drowning victim (Petrass & Blitvich, 2018; Backman, Hollenberg, Svensson, Ringh, Nordberg, Djarv, Forsberg, Hernborg, & Claesson, 2018; Abelairas-Gomez, Barcala-Furelos, Mecias-Calvo, Rey-Eiras, Lopez-Garcia, Costas-Veiga, Bores-Cerezal, & Palacios-Aguilar, 2017; Moran, Webber, & Stanley, 2017). The original review recommendations such as equipping rescuers with the “tools for heroic acts” (Pearn & Franklin, 2009) by performing throws with a buoy or any floating object or the mnemonics, “talk, reach, throw, wade, row, and tow,” or “reach and throw, don’t go” to promote reaching assists) (Royal Life Saving Society Australia, 2006; American Red Cross, 2014) still stand, but without addressed the main question of this review (Szpilman, Løfgren, Webber, Quan, Bierens, Morizot-Leite, & Langendorfer 2013; Moran & Stanley, 2013; Pearn, & Franklin, 2012; Moran, Quan, Franklin, & Bennett, 2011; Franklin, & Pearn, 2011; Venema, Groothoff & Bierens, 2010; Pearn & Franklin, 2009; Michniewicz, Walczuk, & Rostkowska, 2008; Wiesner, 2001; Webber, 2008).

Rescue tubes, ring buoys, throw lines, and rescue lines have been proposed, albeit without strong empirical evidence, as the most “advantageous” types of rescue equipment due to their associated accuracy, buoyancy, distance they can be thrown, and ease with which the person being rescued can grab hold (O’Sullivan, 2013; Szpilman, Løfgren, Webber, Quan, Bierens, Morizot-Leite, & Langendorfer 2013; Moran & Stanley, 2013; Pearn, & Franklin, 2012; Moran, Quan, Franklin, & Bennett, 2011; Franklin, & Pearn, 2011; Venema, Groothoff & Joost, 2010; Pearn & Franklin, 2009; Michniewicz, Walczuk, & Rostkowska, 2008; Webber, 2008; Wiesner, 2001). Specifically, throwing a lifeline or rescue buoy may be one effective lifesaving skill capable of being taught to lay-responders/bystanders although no published studies support that opinion. The four most recent findings support in only a general way the original conclusions of a review by the Rescue Commission of International Life Saving (European Region) which identified a link between the use of ring buoys (i.e. lifebuoy, life

ring, or life belt) by a lay-responders/bystanders and the lives saved as significant and effective among persons in need of aquatic rescue (O'Sullivan, 2013). Additional future empirical research studies are needed.

Selected Reference List. The following references include the most important ones examined as part of the original scientific review and this subsequent triennial review.

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Annotated Scientific Foundation References

Level of Evidence	Definitions (See manuscript for full details)
Level 1a	Population based studies, randomized prospective studies or meta-analyses of multiple studies with substantial effects
Level 1b	Large non-population based epidemiological studies or randomized prospective studies with smaller or less significant effects
Level 2a	<u>Prospective</u> , controlled, non-randomized, cohort or case-control studies
Level 2b	<u>Historic</u> , non-randomized, cohort or case-control studies
Level 2c	<u>Case series</u> ; convenience sample epidemiological studies
Level 3a	Large observational studies
Level 3b	Smaller observational studies
Level 4	Animal studies or mechanical model studies
Level 5	Peer-reviewed, state of the art articles, review articles, organizational statements or guidelines, editorials, or consensus statements
Level 6	Non-peer reviewed published opinions, such as textbook statements, official organizational publications, guidelines and policy statements which are not peer reviewed and consensus statements
Level 7	Rational conjecture (common sense); common practices accepted before evidence-based guidelines
Level 1-6E	Extrapolations from existing data collected for other purposes, theoretical analyses which is on-point with question being asked. Modifier E applied because extrapolated but ranked based on type of study.

Summary of Key Articles/Literature Found and Level of Evidence:

Author(s)	Full Citation	Summary of Article	Level of Evidence
Petrass & Blitvich, (2018)	Petrass, L.A., & Blitvich, J.D. (2018). A lack of aquatic rescue competency: A drowning risk factor for young adults involved in aquatic emergencies. <i>Journal of Community Health</i> , 43(4),688-693	Drowning is an important public health issue with major impacts on young adults aged 15-24 years, yet little is known about the causal factors for drowning for this group. As young adults recreate with peers in unpatrolled aquatic environments, the capacity to perform effective and efficient rescues seems pivotal. This study examined perceived ability of young adults to perform a rescue; determined the level of aquatic rescue knowledge; and measured the effect of an aquatic rescue intervention. In total, 135 participants	Level 3b

		<p>completed pre- and post-intervention surveys and rescue practical testing. Wilcoxon matched pairs signed rank tests were used to assess significant differences pre- and post-intervention and Mann-Whitney tests used to compare groups. Pre-intervention, participants had a low level of rescue knowledge (Mdn = 50) and the relationship between perceived rescue ability and practical rescue testing was weak ($r_s = 0.33, p \leq 0.001$). Post-intervention, ability to perform a contact tow demonstrated significant improvement ($z = -9.09, p < 0.001, r = -0.79$) and rescue knowledge also improved significantly (Mdn = 100, $z = -9.42, p < 0.001, r = -0.81$). Findings were consistent with other studies, which found that laypersons/bystanders lack of knowledge in the areas of the ability to physically execute effective rescue skills, knowledge regarding how to properly execute effective rescue skills, and knowledge required to safely perform a rescue skill, were factors that would more likely increase layperson drowning risks if they attempt an aquatic rescue. Findings concluded that a rescue based intervention could significantly improve competency of a layperson regardless of previous experience and/or qualifications,</p>	
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Backman, Hollenberg, Svensson, Ringh, Nordberg, Djarv, Forsberg, Hernborg, & Claes (2018)	Backman, A., Hollenberg, J., Svensson, L., Ringh, M., Nordberg, P., Djarv, T., Forsberg, S., Hernborg, O., & Claesson, A. (2018). Drones for provision of flotation support in simulated drowning. <i>American Medical Journal</i> , 37(3):170-173.	The purpose of the study was to evaluate and explore the feasibility, efficiency, and potential of using drones for delivering and providing flotation devices in cases of drowning to conscious simulated drowning victims. It was hypothesized that a drone carrying an inflatable life buoy would be a faster way to provide flotation compared with traditional methods. A simulation study was performed with a simulated drowning victim 100 m from the shore. A drone (DJI Phantom 4; dji, Shenzhen, China) equipped with an inflatable life buoy of 60 N was compared with traditional surf rescue swimming for providing flotation. The primary outcome was delay (minutes:seconds). Results of the study revealed of a total number of 30 rescues performed there was a median time for the delivery of the floating device of 30 seconds (interquartile range [IQR] = 24-32 seconds) for the drone compared with 65 seconds (IQR = 60-77 seconds) with a traditional swimming rescue ($P < .001$). The drone had an accuracy of 100% in dropping the inflatable life buoy < 5 m from the victim, with a median of 1 m (IQR = 1-2 m). Conclusions revealed that the use of drones for the delivery of inflatable life buoys was as safe as, and possibly a faster method of rescue to be used to provide an early flotation device rescue to a conscious drowning victim when compared to swimming rescues.	Level 3b
Koon, Rowhani-Rahbar &	Koon, W., Rowhani-Rahbar, A. & Quan, L. (2018). The ocean	The purpose of the study was to investigate the multiple strategies used to prevent drownings in recreational	Level 2b

Quan, (2018)	lifeguard drowning prevention paradigm: how and where do lifeguards intervene in the drowning process? <i>Injury Prevention</i> , 24(4), 296-299.	swim areas, specifically the utilization of lifeguards in recreational swim areas. A retrospective analysis was conducted using lifeguard activity data collected in real time with a Computer-Aided-Dispatch (CAD) system to characterize the nature of lifeguard primary and secondary drowning prevention at a popular ocean beach in California. Preventative actions constituted the majority (232 065/423 071; 54.8%) of lifeguard activities, while rescues represented 1.9%. Results revealed that the most preventative actions and rescues occurred during summer months, weekends and afternoons. Statistically significant geographical clusters of preventative actions were also identified all over the beach, while rescue clusters were primarily restricted to two sites. Using the most reliable and valid collection system to date, these data show spatial and temporal patterns for ocean lifeguard provision of primary prevention as well as secondary drowning prevention (rescue).	
Moran, Webber, & Stanley, (2017)	Moran, K., Webber, J., & Stanley, T. (2017). The 4Rs of aquatic rescue: Educating the public about safety and risks of bystander rescue. <i>International Journal of Injury Control and Safety Promotion</i> , 24(3), 396-405	The purpose of the study was to take a historical retrospective view of layperson/ bystander rescuers between 1980 to 2014, who drowned while attempting to rescue another person in New Zealand (N=87); all incidents occurred in open water and most (80%) fatalities were male. While bystander rescue has been promoted as a way of preventing drowning, little is known about the knowledge base that informs potential rescuers. This study used a family water safety program to	Level 2b

		<p>promote a resource entitled the 4Rs of Aquatic Rescue. Participants (n = 174) completed a pre-intervention survey and were then provided with information and access to electronic resources on safe bystander rescue techniques. Most respondents (71%) had never been taught rescue techniques, and males were more confident of their rescue ability. Upon completion of the program, significant differences were evident in respondents' understanding of rescue safety, but this did not translate to greater confidence or disposition towards performing a rescue. Ways of promoting bystander safety around water are discussed and recommendations for future studies are made.</p>	
<p>Abelairas-Gomez, Barcala-Furelos, Mecias-Calvo, Rey-Eiras, Lopez-Garcia, S., Costas-Veiga, J., Bores-Cerezal, A., & Palacios-Aguilar, J. (2017)</p>	<p>Prehospital emergency medicine at the beach: What is the effect of fins and rescue tubes in lifesaving and cardiopulmonary resuscitation after rescue? <i>Wilderness Environmental Medicine</i>, 28(3), 176-184.</p>	<p>The purpose of the study was to analyze the influence of fins and rescue tube use in a water rescue, assessed by time and distance to salvage position, physiological parameters, and cardiopulmonary resuscitation (CPR). Twenty professional lifeguards (10 men, 10 women) conducted 3 tests: a baseline test of 5 minutes of CPR and 2 water rescues, 1 without rescue equipment (NRE), and the other with fins and rescue tube (FRT). They also had to perform 5 minutes of CPR after each rescue. Time and distance of the rescues, physiological parameters (blood lactate concentration and heart rate), and quality of CPR were analyzed. Results revealed that CPR quality worsened by 26 to 28% (P < .001) after a rescue. However, there</p>	<p>Level 2a</p>

		<p>were no differences using FRT. The use of rescue equipment reduced the time (FRT: 216+/-57 seconds; NRE: 319+/-127 seconds; $P < .001$) and distance covered (FRT: 265+/-52 m; NRE: 326+/-41 m; $P < .001$). No differences were found in lactate levels between FRT and NRE just after the rescues, but there were some after 5 minutes of subsequent CPR (FRT: 10.7+/-2.2 mmol/L; NRE: 12.6+/-1.8 mmol/L; $P < .001$).</p> <p>Comparing women with men, we found significant differences in lactate concentrations only in FRT (women: 9.6+/-1.4 mmol/L; men: 8.1+/-1.2 mmol/L; $P = .031$). Overall it was found that FRT did not have any effect on the quality of the post rescue CPR. The use of fins and rescue tubes provided a comprehensive benefit in an aquatic emergency.</p>	
Michniewicz, Walczuk, & Rostkowska, (2008)	Michniewicz, R., Walczuk, T., Rostkowska, E. (2008). An assessment of the effectiveness of various variants of water rescue. <i>Kinesiology</i> , 40(1):96-106.	<p>Effective performance of a rescue in water without equipment was negligible, placing both the life guard and victim at risk. The use of equipment (i.e. rescue canister) significantly reduces the risk of loss of lifeguards and victims' lives was reduced.</p> <p>The rescue canister selected for this study was identified as one of many useful types of rescue equipment (i.e. rescue tube, ring buoy, rescue line)</p>	Level 3a
Wiesner, (2001)	Wiesner, W. (2001). <i>Bojka ratunkowa – uniwersalny środek pływacki</i> . Materiał wygłoszony na Konferencji Naukowej w Srebrnej Górze. [A	<p>There are advantages and disadvantages with the use of any individual rescue device, There is a specified time needed to swim and tow a victim with the use of individual rescue devices (i.e. rescue tube, ring buoy, rescue canister, safety</p>	Level 3a

	<p>rescue buoy – a universal swimming apparatus. A paper read at the Scientific Conference in Srebrna Góra. In Polish.] /on-line/. Retrieved June 14, 2013 from http://lifeguardgdynia.pl/html/bojka.html</p>	<p>line on a winch, rescue line and ball) over a distance of 20 meters, The use of a rescue tube, ring buoy, and a line on a winch were identified as advantageous? For what, in what way?- shorter tow times?. Suggestion for changes being made in lifeguard training which could lead to participants learning to use a variety of rescue equipment so that they can select a rescue device suitable for them</p>	
<p>Szpilman, Løfgren, Webber, Quan, Bierens, Morizot-Leite, & Langendorfer, (2014)</p>	<p>Szpilman,D., Løfgren, B., Webber,J., Quan,L., Bierens, J., Morizot-Leite,L., & Langendorfer, S.J. (2014). Creating a Drowning Chain of Survival. <i>Resuscitation</i>, 85(9): Supplement 1149-1152.</p>	<p>Identification of “Factors which influence a lay-person’s decision to enter the water to provide help”(i.e. Relationship with victim, Depth of water/distance to victim, swimming and rescue skill of the lay-responder, level of danger associated with the rescue, the consequence of not providing immediate help to the victim, other things) There are two goals, strategic and tactical (strategic = retrieve the victim from the water and tactical = interrupt the drowning process and prevent submersion) that affect a lay person when attempting to helping a drowning victim Most rescuers focus on the strategic goal but a lay responder should focus on following the chain of survival, by calling for help with a focus on the tactical goal, of providing a victim with flotation assistance with rescue equipment (i.e. reach and assists with poles, trees and noodles, shepherd’s crook, and ring buoys.</p>	<p>Level 6</p>
<p>Webber, (2008)</p>	<p>Webber, J.B. (2008). Drowning, the New Zealand way: Prevention, rescue,</p>	<p>Experts recommend learning safe ways to assist others and keep others safe Very little data identifies what rescue</p>	<p>Level 3b</p>

	resuscitation. <i>Resuscitation</i> , 81(2): Supplement 96-106.	skills work best for non-expert rescuers (i.e. lay-person or bystander). Experts support the recommendations of Pearn & Franklin (2009) for bystanders to learn safe non contact rescue techniques (i.e. throw lines or life buoys).	
Pearn, & Franklin, (2012)	Pearn, J.H., & Franklin, R.C. (2012). The impulse to rescue:" Rescue altruism and the challenge of saving the rescuer. <i>International Journal of Aquatic Research & Education</i> , 6(4) 325-335.	<p>Purpose: To dissect and discuss “rescue altruism” and the importance for the need of lay-responder/bystander training in basic lifesaving skills to reduce rescuer-victim deaths by drowning.</p> <p>Findings: Results of the study revealed:</p> <ul style="list-style-type: none"> • “Rescue altruism” creates a sense of personal courage that ignores degree of risk hence increasing the rescuer-victim syndrome. • Aquatic rescues can impact a bystander at anytime hence the solution is to equip all with the "tools for heroic acts" (Franklin & Pearn, 2011) eliminating fatal risks which can be created by such heroism. • There should be a public-access water safety programs to teach rescue techniques without placing the rescuer at risk (i.e. reach and throw, don’t go techniques) • Basic Line-Throwing skills were identified as an important skill in the context of this study. <p>18-year critical incident population study identified 103 victims who drowned while attempting a rescue. (In Australia) In 74% of cases, the primary "victim") survived; 50% of rescuers were visitors not familiar with the water</p>	Level 3b

		<p>hazard; 67% of the drowned rescuers were related to the primary victim. None were professionally trained in aquatic rescue. Rescue altruism is composed of (a) an ethos based on the Good Samaritan or Golden Rule ethic; (b) a subjective identity of the rescuer with the victim, intensified by a perceived duty-of-care relationship; (c) perception of risk in which the potential of rescue-resuscitation success is greater than zero; and (d) personal courage that ignores degree of risk. The unmet challenge therefore is to ensure all members of the public are equipped with lifesaving drills and skills to ensure their safety and those in their care. Because the need to effect an aquatic rescue can confront a bystander at any time, and many confronted with a drowning will act altruistically, the solution is to equip all with the "tools for heroic acts" (Franklin & Pearn, 2011). Such will reduce the risk of rescuer deaths and increase the likelihood of saving the primary victim. Specialist swimming and body-contact rescue skills are the province of professional lifesavers and lifeguards. By contrast, in the context of the general public (i.e., those who are involved in opportunistic bystander aquatic rescues), the basic paradigm of public-access water safety is to teach rescue techniques without placing the rescuer at risk—if at all possible by noncontact outreach, a fundamental principal involved in all international "Aqua Codes" (Franklin & Pearn, 2011; Pearn & Franklin, 2009). The teaching of basic line-</p>	
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		throwing skills is important in this context. It has been shown that only 20% of untrained adults can throw a line within two meters of a target at a first attempt. In the heat of the moment, 20% do not secure the end of the flung rope. Trained children can affect a 10-meter accurate throw and pull a potential victim to safety with a median lapsed time of 23 s (Pearn & Franklin, 2009).	
Pearn, & Franklin, (2009)	Pearn, J.H., Franklin, R.C. (2009). "Flinging the squaler" Lifeline rescues for drowning prevention. <i>International Journal of Aquatic Research & Education</i> , 3(3) 315-321.	Effective performance of a rescue in water without equipment was negligible, placing both the lifeguard and victim at risk. The use of equipment (i.e. rescue canister) significantly reduces the risk of loss of lifeguard's and victim's lives were confirmed. The rescue canister selected for this study was identified as one of many useful types of rescue equipment (i.e. rescue tube, ring buoy, rescue line, Wiesner (2001))	Level 2b
Moran, & Stanley, (2013)	Moran, K., Stanley, T., (2013). Readiness to Rescue: Bystander perceptions of their capacity to respond in a drowning emergency. <i>International Journal of Aquatic Research & Education</i> , 7(4) 290-300.	Bystander rescue and resuscitation of drowning victims seems to contribute to a positive outcome. Bystanders are prepared to take responsibility to rescue a drowning victim in spite of significant dangers. The interventions of bystanders assistance occurs in dangerous situations. Some recent studies have concluded that drowning victims have a good chance of survival when bystander resuscitation has already been started before the arrival of the emergency medical services (EMS). Outcome is poor if rescue or resuscitation is delayed.1–7 Unfortunately, little data	Level 3b

		on what exactly happens during the rescue and resuscitation of drowning victims by bystanders is available.	
Venema, Groothoff, & Bierens, (2010)	Venema, A.M., Groothoff, J.W., & Bierens, J.L.M. (2010). The role of bystanders during rescue and resuscitation of drowning victims. <i>Resuscitation</i> , 81(4) 434-439.	Experts recommend learning safe ways to assist others and keep others safe There is a paucity of data that identifies what rescue skills work best or are performed best by non-expert rescuers (i.e. lay-person or bystander). Experts support recommendations of Pearn & Franklin (2009) for bystanders to be aware of safe non contact rescue techniques (i.e. throw lines or life buoys).	Level 2b
Moran, Quan, Franklin, & Bennett, (2011)	Moran, K., Quan, L., Franklin, R., Bennett, E. (2011). Where the evidence and expert opinion meet: A review of open-water recreational safety messages. <i>International Journal of Aquatic Research & Education</i> , 5(3) 251-270.	The simple skill of throwing a lifeline or lifebuoy should be a lifesaving skill taught to lay-responders/bystanders to decrease needless drowning. It takes a medium time of 35sec for an untrained bystander to throw a lifeline. 20% of lay-responders/bystanders can throw a line within 2m of the target at a first attempt. Trained children can affect a 10m accurate throw and pull a potential victim to safety with a medium elapsed time of 23sec. Study examined swimming ability and variables associated with swimming for US inner-city, minority children. Empirical research on minority children’s swimming ability is non-existent, and drowning rates for this population are high. A large sample (n= 1680) was gathered, which targeted poor, minority children. Parents of children aged 4–11 years and adolescents (12–17 years) completed surveys. African–American respondents reported a 57.5% “at risk” (unable to swim or uncomfortable in	Level 3b

		<p>deep end of pool) swimming ability. Hispanic/Latino children confirmed a 56.2% “at risk” level as compared with 30.9% for white subjects. Age, sex, child’s lunch program, parental education and race variables were all significantly ($p < 0.05$) related to swimming ability. Poor minority children, specifically African–American and Hispanic/Latino, are at a significant disadvantage concerning swimming ability. Female subjects were notably more “at risk” regarding their swimming ability than male subjects. Age, race and socioeconomic factors were significantly associated with children who have low swimming ability.</p>	
Franklin, & Pearn, (2011)	<p>Franklin, R.C., & Pearn, J.H. (2011). Drowning for love: the aquatic victim-instead-of-rescuer syndrome: drowning fatalities involving those attempting to rescue a child. <i>Journal of Pediatrics and Child Health</i>, 47, p. 44-47.</p>	<p>Parents and guardians instinctively will go to aid a drowning child. In this study male parents or partner of a first degree relative (i.e. lay-person or bystander) would be the first to respond. The rescuer often drowns. This condition is defined as aquatic victim-instead-of-rescuer (AVIR) syndrome. The authors stated that parental empowerment of personal life saving skills is was a practical way to eliminate/reduce the double tragedy drowning syndrome (AVIR). Having basic non-contact rescue skills is a secondary prevention which prevention, which would be beneficial, hence increase education that increases acquisition of aquatic rescue skills. AVIR syndrome could be reduced if more awareness can be brought to the risks which cause AVIR syndrome (i.e. unfamiliar water hazards; the sea; tourists or oversea</p>	Level 2b

		<p>visitors). Parents should have basic life saving skills of non-contact rescue (i.e. throwing a life line). Experts support recommendations of Pearn & Franklin (2009) for bystanders to be aware of safe non contact rescue techniques (i.e. throw lines or life buoys). Experts recommend learning safe ways to assist others and keep others safe. There is a paucity of data that identifies what rescue skills work best or are performed best by non-expert rescuers (i.e. lay-person or bystander). Experts support recommendations of Pearn & Franklin (2009) for bystanders to be aware of safe non contact rescue techniques (i.e., throw lines or life buoys).</p>	
<p>Mecrow, Rahman, Linnan, Scarr, Mashreky, Talab, & Rahman, (2014)</p>	<p>Mecrow, S., Rahman, A., Linnan, M., Scarr, J., Mashreky, R., Talab, A., Rahman, A.K., (2014). Children reporting rescuing other children in rural Bangladesh: A descriptive study. <i>Injury Prevention</i> published first online March 31, 2014 as 10.1136/injuryprev-2013-041015. Retrieved October 27, 2014 from http://injuryprevention.bmj.com/</p>	<p>In Bangladesh, children report frequent drowning rescues of younger children in rural areas. Whether trained in the Swim Safe program or a natural swimmer, all rescuers entered the water. Swimming rescues where the rescuer had to swim to reach the victim accounted for about half of all in water rescues. There was no difference in swimming rescues between the trained SwimSafe graduates and natural swimmers. Cultural and Socioeconomic Implications and drowning environments play a huge role in Water Safety and education in high income countries and low to middle income countries. HIC have safety legislation, which usually require safety equipment and professional supervision regularly use public swimming areas. This lessens the need for a bystander rescuer to enter the</p>	<p>Level 3a</p>

		water to conduct a contact rescue. The study suggests that in-water rescue techniques and land-based rescue techniques should be taught to all children as well as added to Swim Safe program. AVIR syndrome is present regardless of socioeconomic differences in HIC and LMICs. The study found that children conducted in water rescues that involve contact even if they received training in safer land-based techniques based on the different aquatic environments as compared to HIC aquatic environments and lack of access to water safety equipment (i.e. reach and extension devices). More effective water safety education, risk knowledge and adult supervision are needed.	
O'Sullivan, (2014)	O'Sullivan, M. (2014). Public Rescue Equipment-The ring buoy as a lifesaver. <i>World Conference on Drowning Prevention</i> . Retrieved on Dec 20, 2014 from http://www.wcdp2013.org/uploads/media/Prevention8_4_130_Public_Rescue-Equipment_MartinOSullivan.pdf	Based on Irish Water Safety Program data gathered over a 7-year period (2006-2012), the use of ring buoys by lay-responders and the numbers of lives saved was significant. Ireland is one of the few countries in Europe where ring buoys were extensively deployed as public rescue equipment. In Ireland ring buoys are accessible on all public beaches 100meters apart. Ring buoys are also placed along riverbanks, lakesides, and marinas. IWS education regarding the proper use of the ring buoy for saving a person in need of water rescue, was identified as the most effective type of rescue equipment for a public access environment.	3b
Evans, (2004)	Evans, W. (2004). Risk Management for your	Throw ropes are one of the best pieces of rescue equipment available in	Level

	<p>Aquatic Safety Program. <i>Markel Insurance Company</i>. Retrieved on May 6, 2014 from http://www.aquaticsafetygroup.com/pdf/markel-aquaticriskmgmtguide.pdf</p>	<p>remote aquatic environments or on canoe and kayak trips. Used properly, they can extend the reach of rescuers Consistent accuracy with a throw bag takes practice This knowledge is not limited to Whitewater Rivers, but can be applied to pools & remote locations where a rescue tube is not available...”</p>	<p>3b</p>
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Summary

A scientific review of the literature regarding the evaluation of effective water rescue equipment for a lay-responder has echoed the sentiment of “rescuer altruism” in presence of layperson/bystander, when a victim is in need of an aquatic rescue (Mecrow, Rahman, Linnan, Scarr, Mashreky, Talab, Rahman, 2014; Pearn, & Franklin, 2012; Venema, Groothoof, Bierens, 2010). In addition, the literature further supports the sentiment that laypersons/bystanders are willing to take responsibility to rescue a drowning victim in spite of significant dangers (Petross and Blitvich, 2018; Moran, Webber, & Stanley, 2017). How a bystander most effectively and safely achieves a rescue while staying out of the water is unclear. Limited data suggests that bystanders need psychomotor preparation, i.e. training, to use rescue devices. General consensus supports use of equipment using a rescue device. However, what specific rescue device is most effective, safe and easily learned is not known. Experts and agencies acknowledge that the use of any individual rescue device has advantages and disadvantages with.

Overall Recommendation

Although there remains a limited amount of empirical research regarding the most effective type of water rescue equipment for a lay-responder to use when assisting a victim in an aquatic environment, the current recommendations of rescue equipment including throw ropes and lines and ring buoys for effective use by bystanders, continue and seem to contribute to positive outcomes (O’Sullivan, 2015; Pearn & Franklin, 2009). The recommendation of this guideline results from this 2019 review of the updated research evidence. It remains the contention of expert opinion that teaching layperson/bystander rescue skills should also become a part of water safety classes and guidelines in efforts to reduce the

drowning rate and increase safer and more effective bystander intervention skills. Additionally, targeted interventions are needed to address this need in multiple aquatic environments (e.g., high-risk aquatic activities such as kayaking, white water rafting; jet skiing). The development of public-access water safety programs such as current American Red Cross Water Safety programming, (e.g., “reach and throw, don’t go” techniques) may aid in decreasing drowning deaths annually.

Recommendations and Strength

Standards: None

Guidelines: None

Options: Reaffirm prior recommendation of an *option* that rescue equipment such as throw ropes and lines and ring buoys can be used effectively by bystanders, with the following clarification that there is no research recommending or comparing the use of one type of equipment over another.

Conclusions and Further Considerations

There is a need to monitor the scientific literature including new research studies and most recent evaluation of effective water rescue equipment for lay-responders statement. As an outgrowth of this review, additional scientific reviews need to identify appropriate pedagogical and learning practices to add to basic water safety and learn-to-swim programs to teach lay persons how to use equipment.