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Drowning Prevention: Define and Then Gather Evidence or Gather Evidence to Define?

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Abstract

According to the World Health Organization, drowning fatalities are a neglected public health issue ranked as the third most frequent cause of unintentional death by injury. Data used to record drowning incidents are acknowledged as inaccurate. Recommendations on drowning prevention based on these data are currently not informed by accurate, detailed and reliable evidence. Two modifications to current practice are proposed: 1) an Aquatic Incident Report needs to be developed as an extension of the current workplace incident report to prompt for information commonly not included in current drowning reports; and 2) National Water Safety Plans should be modified to include a learn-to-swim program database registering the name/elements of programs taught. Worldwide implementation of these modifications is the goal. Using improved information databases will enable researchers to better identify patterns in the drowning data. Improved current data collection methods will lead to more informed recommendations on drowning prevention.

Keywords: drowning prevention, data collection, swimming database, aquatic incident report, swimming skill, water safety

Most of what we know regarding the impact of fatal drownings within each country or region around the world is based on the statistics gathered from a variety of government, water safety, lifesaving, and other collection agencies, such as rescue organisations. The nature of these data that these agencies collect, how they collect them, and how and whether they report these data vary across agencies (International Life Saving Federation, 2012a). These divergent approaches to data collection were even more problematic prior to 2002 due to differing definitions of 'drowning' (Van Beeck, Branche, Szpilman, Modell, & Bierens, 2005). The lack of consensus on what represented drowning, the absence of coordinated research, and varying treatment for drowning survivors led to the first World Congress on Drowning in 2002 (Bierens, 2006; 2014). This Congress (now evolved into the biannual World Conference on Drowning Prevention) initially addressed the problem of defining drowning and organised international professionals into expert panels in approximately 10 areas in order to compile recommendations for the prevention, rescue, and treatment of drowning victims. At the first 2002 Congress, a consensus definition of drowning was established in order to aid the gathering of data and assist researchers by having a uniform definition. The initial consensus definition of drowning was: '*The process of experiencing respiratory impairment from submersion/immersion in liquid*' (Van Beeck et al., 2005).

One of the primary organisations involved on the expert panels of this first Congress was the International Lifesaving Federation (ILS). This world water safety organisation has the stated aim of taking a leading role in defining and articulating solutions to reducing the problem of drowning (International Life Saving Federation, 2015). Using the 2002 definition, the ILS completed the first global drowning report in 2007 that highlighted the drowning problem,

revealed the limitations of global and regional drowning estimates, and demonstrated the need for further research (International Life Saving Federation, 2012a). The report highlighted the following difficulties encountered in collecting data for this report: 1) an absence of extensive or complete drowning data collection in some countries; 2) lower quality data from several countries; and 3) an absence of any data from other countries and regions with large populations that were expected to report high drowning rates (International Life Saving Federation, 2007).

The quality and extent of the gaps in the fatal drowning data were discussed at the World Conference on Drowning Prevention in 2011, following which the ILS completed a survey of its member nations in 2012. This information gathered by the ILS has been used as a resource by the World Health Organization (WHO) to produce fact sheets on the impact of drowning on global public health. It was not until the WHO released its own first report in 2014 dedicated exclusively to drowning that the continuing problematic situation regarding data collection and reliability was corroborated. Both the WHO and the ILS now have highlighted the poor quality and lack of complete and comprehensive fatal drowning data (International Life Saving Federation, 2012a; World Health Organization, 2014). Although clear indications existed that drowning prevalence was underestimated (Moran, 2010), drowning was still ranked as the third most frequent cause of death by unintentional injury in the WHO report that emphasised the need to address drowning prevention as a major public health issue (World Health Organization, 2014).

Shortcomings of Data on Drowning

Despite the fact that 372,000 fatal drownings were reported globally in 2012 (World Health Organization, 2014), drowning remained a largely neglected and underreported public health issue that has lead to the true magnitude of the problem remaining unknown. As part of the 2002 consensus definition of drowning, three possible outcomes of a drowning event existed: fatality, morbidity, or no morbidity. The latter two outcomes collectively were labelled as 'non-fatal drowning.' Thirteen years after its initial adoption, the revised drowning definition still has not been widely disseminated outside of research agencies or academia nor has it uniformly been adopted by the aquatic industry or the lay community in general. The lack of dissemination of the definition has meant that only data on fatal drownings have been reported because many people still believe that 'near drowning' does not count as drowning. This underreporting has impacted not only the accuracy of drowning statistics but also the true extent of the problem to develop informed and effective prevention strategies (Moran, 2010). The fact that drowning continues to be a leading cause of death in spite of the acknowledged underestimation of fatalities highlights the importance that needs to be placed on its prevention (World Health Organization, 2014).

A number of reasons have existed for the underreporting of drowning. It is partially due to the inadequate collection of data already noted, especially in low- and middle-income countries (LMICs). In addition, the focus only on fatal drownings has resulted in the consequent failure to report non-fatal drownings incidents. Another issue has included how drowning deaths are classified. For example, statistics currently exclude intentional drowning (e.g., as a result of suicide or homicide), drowning deaths as a result of flood disasters or storm surges, and water transport incidents and tsunamis (World Health Organization, 2014). The 2012 survey of ILS members revealed that the drowning rate calculated by the WHO using the Global Burden of Disease (GBD) underestimated the true rate in some countries by 50 - 300% compared to the rate calculated by the member country itself using the data from their own agencies (International Life Saving Federation, 2012a). This large discrepancy between drowning rates was attributed to the GBD 2008 dataset for the majority of LMICs was produced as a result of modelling and was due to large gaps in the health system capacity in these countries at the time (International Life Saving Federation, 2012a).

Another important issue associated with the discrepancies was the wide variety of agencies that collected data on drowning. Each nation, or in some cases, region or provincial area within each country, may have a different agency responsible for collecting fatal drowning data. Agencies include central government agencies and coronial systems; water safety, lifesaving, and rescue organisations; armies, police, and fire departments; universities (exclusively in high income countries); and private organisations (International Life Saving Federation, 2012a). The methodology used to record drowning statistics by each of these agencies often varies widely. The statistics may be calculated from an assortment of sources including central death registries, coronial or medical examiners' reports, hospital records, rescue reports, media reports, or a combination of these sources. The variables collected from these sources also differ widely with some agencies collecting variables such as age, sex, time including season, location, activity prior to drowning (if known), and victim risk behaviour (e.g., involvement of alcohol/drugs, lack of use of lifejacket, reckless behaviour, if known). Collection of some or all of these variables may be difficult, especially in LMICs where they do not collect or have the capacity to collect as many variables as organisations in high income countries (HICs). For example, LMICs may not be able to collect data on casualties who do not come to medical attention and/or who are buried quickly due to local cultural beliefs. Consequently, the widely-variable methodology of reporting drowning incidents within and across countries affects the reliability (i.e., consistency) of the accuracy of drowning statistics which in turn may seriously underreport worldwide fatal drownings.

Swimming and Drowning Prevention

The activity of swimming has been around for as long as humans have recorded it. Whether it was the 'cave of swimmers' drawings from the Stone Age - estimated to be 8,000 years old - or references from the Old Testament of the Bible, it has been common knowledge that the inability to swim carries a higher risk of drowning (Brenner, Saluja, & Smith, 2003; Unidentified author, 2003). Therefore, learning to swim has become one of the more logical drowning prevention strategies through the ages. The axiomatic belief that swimming skills prevent drowning is the basis for the WHO recommendation drowning prevention strategy to improve swimming and water safety skills (World Health Organization, 2014). This belief is subscribed to by the WHO, the ILS, and other nationally-based water safety organisations, such as lifesaving societies.

Over time, however, where and how people are taught to swim has changed, as has what they are taught (Day, 2010). Hence, the link between drowning prevention and swimming as it is known today, and especially as it is practised in HICs, remains unclear. Without data on exactly how swimming is taught, informed recommendations cannot be made on what learn-to-swim methods are protective for drowning prevention. While a person who lacks any swimming skill is likely to drown if unexpectedly immersed in deep water, it does not necessarily follow that an individual who has narrow swimming skills (e.g., only competitive strokes) can avoid drowning in the same situation. Understanding the relation between types of swimming skills and the outcome of drowning incidents, may provide pertinent information for future research into drowning prevention. It remains unknown whether the inclusion in drowning reports of information on the type of swimming skills a victim has learned prior to the incident will indicate potential solutions to the current problems with the data completeness.

Whether a drowning victim had possessed any swimming ability or undertaken learn-to-swim (LTS) program(s) is not currently recorded in drowning reports, even if this information is available. Hence, statistical analysis of drowning data to identify trends linking prior swimming experience to drowning outcome is not a viable avenue of research. For ethical reasons, it is not possible to conduct studies to assess which swimming skills do not prevent drowning. However, some evidence from interventions in Bangladesh, a LMIC with a high drowning rate, may enlighten this issue. The implementation of a swimming and water safety skill program (SwimSafe) over recent years has had a measurable impact on drowning of rural children in Bangladesh, reducing drowning fatalities by 93% (Mecrow et al., 2015; Rahman et al., 2012). Although modelled on swimming and water safety skill programs in HICs, this SwimSafe program in Bangladesh taught swimming that was 'basic' and placed equal in importance on water safety. The program was also conducted predominantly in existing aquatic environments, such as ponds, that had been modified to allow a safe introduction to swimming (SwimSafe,

2015). In contrast, the SwimSafe program as taught in HICs such as Australia and New Zealand has developed a focus on the sport of swimming that is offered in aquatic environments that are highly controlled, deemed safe through the presence of supervision and ensure learner comfort (for example qualified teachers, swimming aids, clean, clear and warm still water (AUSTSWIM, 2014). While these two HICs do not suffer from the same high rate of drowning reported in Bangladesh, their version of the SwimSafe program has not resulted in a similar impact on their drowning tolls. The efficacy of the Bangladeshi study may be a product of the type of swimming skills taught, the focus on water safety and/or the environment in which they are taught, and/or the initial high drowning rates.

What to Teach in Learn-To-Swim Programs?
The WHO global report on drowning recommended to *'teach school-age children basic swimming, water safety and safe rescue skills'* (World Health Organization, 2014, p. 25). This recommendation clearly identifies the type of swimming that needs to be taught for prevention of drowning. In fact, the importance of water safety awareness and basic swimming skills was further emphasised in item seven of 10 community-based actions for drowning prevention recommended in the WHO report, recommending improving '*water safety awareness and basic swimming skills'* (World Health Organization, 2014, p. 33). Yet, what exactly is meant by the terms 'basic' swimming skills and water safety 'awareness'? While the ILS defined 'basic aquatic survival skills' in 2012 and the American Red Cross defined 'water competence' in 2015, still no consensus, nationally or internationally, exists on defining 'swimming' (basic or otherwise) in terms of drowning prevention (International Life Saving Federation, 2012b; Quan et al., 2015). In response to the lack of consensus, a recent article by Stallman, Moran, Quan, and Langendorfer (2017) has proposed fifteen water competence elements for which the authors cite published research evidence to demonstrate a relationship to drowning prevention. Perhaps these or other articles will eventually become the basis for such consensus.

From an ad hoc approach that had developed over the centuries, since the latter half of the 20th century the LTS industry in HICs has progressed to a system that has implemented standards and continuity amongst swimming instructors and appropriate pedagogical approaches for learning to swim (AUSTSWIM, 2014; Colwin, 2002; Love, 2007). Yet there remains high variability between LTS programs in HICs. The emphasis on water safety within the LTS industry as a whole and amongst individual programs has increased markedly over the last 10 years. The extent of the emphasis on water safety and drowning prevention plus the specifics of the water safety components being taught are inconsistent and open to interpretation from individual organisations and instructors (Quan et al., 2015; Ramos et al., 2015).

While it is sometimes possible to distinguish differences in content between LTS programs from their names, some programs may have the same name but different content. The SwimSafe program, for example, has operated in Australia, New Zealand and Bangladesh, and while there are links between how the programs were developed, their aims and focus are not equivalent for each country (Mecrow et al., 2015; SwimSafe, 2015). In Australia and New Zealand, the SwimSafe programs are directed towards improving children's proficiency to propel themselves through water using a small number of strokes for the primary purpose of increasing recreational and competitive swimming and sporting opportunities. These LTS lesson programs are conducted predominantly in enclosed, heated, clear water pools. In contrast, the Bangladeshi implementation of the SwimSafe program is aimed at teaching very basic swimming, water safety, and rescue skills in as short a time period as possible in local watercourses that have been modified to create a safer swimming learning environment (SwimSafe, 2015). This fundamental difference in the implementation of the SwimSafe program between countries can be observed through the SwimSafe website launched in conjunction with the Bangladeshi study which not only specified what was being taught in the program, but how long it ran, where it ran, and who taught it. The website highlighted that: *"SwimSafe is designed to protect against drowning in all children, so it must cover all children, regardless of their talent or interest in further training. It is only the most basic level of swimming."* (SwimSafe, 2015). It seems likely that it is the emphasis on drowning prevention, with only the most basic level of swimming skill taught, combined with an emphasis on water safety, that accounts for the marked reduction in childhood drowning rates achieved by the Bangladeshi program (Mecrow et al., 2015; Rahman et al., 2012).

Although a few studies linking swimming and drowning prevention have been conducted (e.g., Brenner et al., 2003; Brenner et al., 2009; McIntosh, 2009), notable limitations exist within this research. Key elements taught within various LTS programs include water familiarisation, water safety, self-rescue and basic propulsion using recognised strokes (e.g., front and back crawl and breaststroke normally introduced initially and survival backstroke, sidestroke, and butterfly introduced only when students achieve more proficient levels of skill in the water). While a positive link between formal swimming lessons and drowning prevention was identified in these studies, they were unable to specify which elements were included in the formal swimming lessons. Moreover, the age group investigated was limited to children under five years of age. The capability to compare the effectiveness of these programs in terms of drowning prevention was impeded because many LTS programs have not specified what tasks are included in their formal lessons. Comparisons of LTS programs have been hampered by several issues: 1) LTS programs might have the same generic name, but might not teach the same key elements or emphasize similar elements; 2) many LTS programs have not been registered with a national body and where

the elements taught in the program have not been listed in a central database; and 3) the efficacy of individual elements of individual LTS programs have not consistently been studied by researchers.

Two-Fold Approach to Fixing Data Problem
Addressing the issue of the global burden of fatal drowning has been hampered by the limitations and inaccuracies in the drowning statistics collected by agencies. These drowning data, even with their acknowledged limitations, should be used to direct research into drowning prevention strategies and to form the foundation for drowning prevention recommendations from the ILS and WHO to the world community at large. Future recommendations on drowning prevention would be improved if the scope of data included the identification of the level of swimming education and experience of drowning victims, but also the specific elements of LTS programs victims had undertaken in order to identify key components that were most strongly associated with reducing drowning risk.

In order for agencies to resolve the problems associated with collecting detailed drowning incident information, the WHO Global drowning report offered four overarching recommendations:

1. *All countries should implement proven drowning prevention strategies, tailoring to their own circumstances and risk groups;*
2. *All countries should take steps to improve data about drowning;*
3. *All countries should aim to develop a national water safety plan;* and
4. *A global partnership for drowning prevention should be established.*

(World Health Organization, 2014, pp. 42-43).

In order to develop tailored drowning prevention strategies (WHO recommendation 1), it is critical to collect more in-depth data regarding not only fatal and non-fatal drowning incidents but also the environmental situations in which the incident had occurred (WHO recommendation # 2). A potential solution for agencies in different countries to address recommendation 2 is to develop an Aquatic Incident Report (AIR, Appendix 1) and disseminate it through all the current avenues linked to the teaching and use of resuscitation. The purpose of the AIR would be to address and guarantee the quality and completeness of drowning data by prompting people involved with a drowning incident, whether as witness, rescuer, first responder, or hospital or aftercare worker, to note critical information regarding the incident.

One of the issues associated with the drowning data currently collected has been that members of the immediate family, neighbours, or responders of the victim may have important, relevant information about the drowning incident, but at no point in the process had they been prompted to offer it so it

may be recorded in a database. The AIR is designed to be completed through various stages of the drowning incident process (i.e., background about the victim and environment prior to the incident, initial incident, immediate care, after care) for fatal and non-fatal drowning incidents. The use of AIR would prompt those both reporting and recording the incident to ask and answer questions that can be vital for archival and future research purposes. Completion of the AIR should enable a more comprehensive database that will enable statisticians to cross reference drowning incidents, to differentiate between mass drowning events and individual incidents, and to allow for the agencies responsible for collection of drowning data to follow up on information regarding a previously-reported event.

According to the WHO global drowning report's recommendations, a National Water Safety Plan (WHO recommendation 3) should aim to:

- *Raise awareness of safety around water and the importance of drowning prevention*
- *Build consensus around solutions and develop a coherent, effective response involving all relevant partners*
- *Provide strategic direction and a framework to guide multi-sectoral efforts to prevent drowning*
- *Monitor action, including obtaining better data and reporting on drowning and prevention.*

A National Water Safety Plan should also incorporate the following strategic principles:

- *Appropriate targets*
- *Coordinated and integrated*
- *Evidence-based and*
- *Data driven.*

(World Health Organization, 2014, p. 36).

Countries like Australia already have developed a National Water Safety Plan that addresses the WHO recommendation 3. Nevertheless, there is a need to increase the scope of this specific plan by including the creation of a database that records the name of each LTS program available nationally and the specific elements and tasks used by each program to teach swimming, water safety, and self-rescue. The inclusion of such a database should be designed to work in conjunction with the AIR to improve the quality and comprehensiveness of drowning data and to revise LTS programs.

The modification of an existing National Water Safety Plan in each country (or the establishment of one where one currently does not exist), combined with the introduction of the AIR and a LTS database should improve the quality, comprehensiveness, completeness, universality, and generalizability of drowning statistics throughout the world. If the AIR worked

within existing networks in each country that have been responsible for collecting and disseminating information and training resuscitation practices, the dissemination and uptake could be enhanced. In HICs, implementation could be facilitated through existing global networks that already use an incident report form (e.g., *Safe Work Australia*) along with online applications (such as smartphone and tablet applications), and dissemination tools such as social media, traditional media and government policy (e.g., inclusion in workplace safety legislation). In LMICs, in addition to formal government channels, implementation could be further facilitated in rural areas where literacy and online access are inconsistent by training and using community leaders and outreach centres that are more likely to have access to drowning incident information than local authorities.

Conclusions

Improving the quality and completeness of data collected on fatal and non-fatal drownings could assist research into drowning prevention and increase our understanding of risk factors associated with drowning. A clearer understanding of the circumstances of drowning incidents could lead to more specific, evidence-based recommendations regarding prevention strategies which in turn could reduce the financial and emotional costs of drowning in communities. Providing a clearer understanding of some of the indirect influences to drowning incidents could also lead to a stronger evidence base for research into LTS programs and curricular reform in terms of the efficacy in drowning prevention.

We believe the modification of National Water Safety Plans to include a combination of AIRs and national LTS databases is one feasible, practical solution that uses a multi-sectoral approach. This is in line with the WHO recommendation 4 (WHO, 2014) for specific strategies related to infrastructure, public awareness, appropriate policies and legislation, and LTS programs, because drowning risk is influenced by a wide range of industries including maritime transport, fisheries, disaster risk management, public health, and rural development. While this proposed solution would not offer instantaneous results, it should have the capacity to provide a solid foundation of evidence to enable these multiple industries (e.g., government, private and health as well as aquatic industries) to collaborate to reduce the global burden of drowning.

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