ENCYCLOPEDIA
on Early Childhood
Development

Injury Prevention: Drowning

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Introduction

Worldwide, over 175,000 children under 20 years of age died from drowning in 2004.[1] For each fatal event it is estimated that there are 1-4 non fatal submersions.[2-5] Those who survive events serious enough to warrant medical attention are often left with permanent neurologic impairment.[6] Importantly there are prevention strategies that are effective; however, consistent implementation of these strategies remains a challenge.

Subject

Drowning is defined as a “process resulting in primary respiratory impairment from submersion/immersion in a liquid medium.[7] This definition includes fatal and nonfatal events. In most countries drowning rates peak in 1-4 year olds, with estimates of more than 30,000 deaths per year.[1] Deaths due to floods and water transport accidents are generally excluded from counts; thus, the true number of deaths is likely much higher, especially in low- and middle-income countries. Statistics on nonfatal events are not systematically collected making it difficult to estimate the full extent of the problem. Prevention strategies are dependent on the specific circumstances surrounding each event, as well as the developmental stage of the child.

Problems

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While drowning is a leading cause of injury-related death in all countries, it takes its greatest toll in low- and middle-income countries. Rates in 1-4 year olds range from 2.8/100,000 in high-income countries to 12.7/100,000 in low- and middle-income countries.[1] Rates also vary within countries. For example, in China, rates of drowning in the 1-4 year age group range from 7.7/100,000 in urban areas to 20.1/100,000 in rural areas.[8] In the United States, rates in the same age group for the five-year period of 2002-2006 ranged from <1/100,000 in Connecticut to 8.0/100,000 in Florida.[9] These variations are directly related to varying exposure patterns to water.

The most frequent location of drowning varies with age and developmental stage of the child.[10-12] Infants are most likely to drown in a bathtub, bucket or other relatively small body of water in the home. The circumstances most often involve a lapse in adult supervision, usually when the caregiver leaves the child unattended or in the care of another child for just a few moments, only to return and find the infant submerged under water. As children become more mobile, drownings are most likely to occur outside the home but in a body of water close to the home. The circumstances generally involve a toddler gaining access to a body of water without knowledge of the supervising adult. In developed countries, the body of water is most often a residential pool, whereas in developing countries, the body of water might be a canal, ditch, well, pond or other body of water near the home.[10-12] In both scenarios the child usually has direct access to the body of water from the home.

Research Context

Numerous studies have examined the epidemiology of drowning in high-income countries (e.g., Australia, Canada and the United States).[10,11,13,14] There are fewer studies in low- and middle-income countries; however, the general patterns that are seen are comparable, with young children being at greatest risk.[12,15] Prevention strategies can be classified on a continuum from passive strategies, requiring no action or only a one-time action at the individual level, to active strategies, requiring repeated action at the individual level. In general, passive strategies are thought to be more effective in preventing injuries than are active strategies. One such passive strategy for prevention of drowning is installation of a fence that completely surrounds the body of water. However, it is clear that no one strategy will prevent all drowning but rather that the approach to prevention should be multifaceted.

Key Research Questions

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- What is the true magnitude of the problem?
- What are the long-term sequelae of nonfatal events?
- What strategies are available and effective for prevention of drowning in bathtubs and other small bodies of water in the home?
- Which passive strategies are effective in preventing drowning among young mobile children?
- How effective are active strategies, such as interventions that aim to improve adult supervision?
- How effective are swimming lessons in preventing drowning among 1-4 year olds?

Recent Research Results

Although great strides have been made in data collection efforts around the world, the availability and quality of drowning data varies greatly among countries, depending on the surveillance systems in place and the availability and quality of other statistical resources. Despite limitations in data, a few patterns have been found. For example, across the globe, rates of fatal drowning are higher in males than females.[1] This is true in all age groups with the exception of infants less than one. Second, a seizure disorder or epilepsy is known to increase the risk of drowning death in all bodies of water, including bathtubs, swimming pools, ponds and other natural bodies of water.[16,17] Thirdly, there is some evidence to suggest that child drowning is associated with socio-demographic characteristics such as the level of education of the family head or caregivers.

With regards to interventions, there is good evidence that passive strategies that either remove the risk or create a barrier impeding access to water are effective in reducing drowning rates. Examples include a four-sided fence surrounding a swimming pool, completely isolating the pool from the home or placing a cover on a well or emptying water from large containers when not in use.[18,19] A Cochrane systematic review of the research evidence and meta-analysis of pooled data from three case control studies showed that there was a significantly reduced risk of drowning in a fenced pool compared to an unfenced pool.[18] This review found that isolation fencing (4-sided fence) was shown to be far more protective than perimeter fencing (3-sided fence where the house or other structure forms part of the barrier) with an odds ratio of 0.17 or a 83% reduction in risk. We are unaware of studies examining use of isolation fencing for other bodies of water (e.g., ponds).

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Examples of behavioural interventions include teaching a child how to swim or an intervention designed to increase adult supervisory behaviour. Recent studies in the U.S. and China have suggested that formal swimming lessons reduced the risk of drowning in the 1-4 year age group by 40%-88%.[20,21] The need for constant adult supervision when young children are in or around water goes without saying. However, studies of interventions to increase supervision are lacking. While there are no studies in the published literature that formally evaluate the effectiveness of lifeguarding as a primary prevention measure, trained lifeguards on beaches and at public swimming pools can model safe behaviours, control the risk-taking behaviours of pool swimmers and beachgoers, and can provide timely rescue and resuscitation so that the drowning events do not result in death or brain damage.[22] A number of studies of adults have suggested that life vests offer some protection against drowning, particularly when worn while boating.[23,24,25] While the effectiveness of life vests for prevention of drowning among children has not been evaluated, it is likely that under similar circumstances life vests would also be protective for children. Studies have shown that once a drowning occurs, survival rates and outcomes are better if the child is resuscitated immediately rather than waiting for emergency personnel to arrive.[5] Thus, knowledge of CPR by lifeguards and/or other bystanders is an important secondary prevention strategy.

Research Gaps

Studies are needed to define the epidemiology of drowning in low- and middle-income countries. In particular the circumstances surrounding the events need to be delineated to identify potential prevention strategies. Once circumstances are defined there is a need for identification of novel passive strategies for prevention of drowning in bodies of water that are not easily fenced (e.g., canals and ditches). Intervention studies are needed to assess the effectiveness of swimming lessons at the population level. Studies are needed to assess the effectiveness of interventions aimed at increasing adult supervision of both infants and 1-4 year olds when in or around water.

Conclusions

Drowning is a leading cause of injury-related death throughout the world. Toddlers are particularly vulnerable as they are at a developmental stage of curiosity and exploration and they have motor skills that allow them to gain access to an open surface water. Yet, they are not yet cognitively able to understand the risk of submersion. Examination of the circumstances surrounding drowning is important for development of targeted strategies for prevention. For young children the most common scenario is submersion in a body of water in or around the home. Interventions

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include removal of the risk or creation of a barrier. Importantly barriers will not address all scenarios. Other interventions include efforts to improve adult supervision and strategies to improve survival or outcome once a submersion occurs. Examples of the latter include teaching young children how to swim and teaching adult supervisors how to perform cardiopulmonary resuscitation. It is clear that prevention campaigns must utilize a multifaceted approach to deal with the many circumstances leading to this tragic outcome.

Implications

Parents and other caregivers must be counseled to never leave a young child unattended when in or around a body of water, whether it be a pond, a bathtub or a pool. Further, there should be layers of prevention in place. Residential pools must be completely surrounded by a barrier that prevents access by a toddler to the water. Barriers, such as covers on wells, should be used for other bodies of water, when feasible. Whenever possible the hazard should be removed. For example, water should be emptied from large buckets after use. Those caring for children should be trained in CPR as early resuscitation is associated with a more favorable outcome. Young children should be taught how to swim but caregivers must be cautioned that swimming lessons alone will not prevent drowning. Finally, legislation mandating pool fencing should be enacted as studies have shown that such legislation increases implementation of this proven strategy.

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