American Red Cross
American Red Cross Advisory Council on First Aid, Aquatics, Safety and Preparedness

ACFASP Scientific Review

Minimum Age for Swimming Lessons

Questions to be addressed:

Primary Question:

What scientific evidence exists to support setting a minimum age for swimming lessons?

Corollary questions:

Does evidence exist to support an optimal age for acquiring swimming and aquatic skills?

Does evidence exist to support a universal order of acquisition for swimming and aquatic skills?

Does evidence exist to identify the most appropriate purposes and methods for aquatic programs for young children?

Introduction/Overview:

The earliest and/or optimal age(s) at which aquatic skills should be introduced within structured (a.k.a., formal) swim lessons has continued to be a persistent and controversial issue in the aquatic and medical fields for over four decades. The controversy in part stems from differing theoretical perspectives underlying the nature of skill acquisition as well as the practical purposes for which swim lessons are offered. One developmental theory, *maturation*, assumes that all behaviors including aquatic skills change over time in a regular, ordered pattern as a result of internal, hereditary-based processes mainly dependent upon a person's chronologic age. A contrasting theory, *learning*, presumes that behavioral changes primarily depend upon specific environmental experiences or sometimes the interaction of those experiences with age. Finally, a new contemporary theory, *dynamical systems*, sees behavioral change as possessing inherent emergent characteristics strongly associated with the elements of complex systems as well as dynamic, physical, and psychological principles. Theoretical perspectives strongly influence how persons or organizations understand why and how behaviors such as aquatic skills change over time.

More pragmatically, aquatic programs, while indirectly and subtly influenced by theory, have been primarily shaped by their underlying purposes. For example, some programs offer swim lessons as a means to "drownproof" infants and young children. Some other programs have proposed offering swimming lessons at a young age in order to develop precocious swimming skills for fostering competitive swimming or survival skills. There is even one study that hypothesized early acquisition of swimming skills promotes enhanced motor control and coordination as well as intellectual skills (Diem, 1982). In contrast, the primary national agencies in the U.S. (e.g., American Red Cross; YMCA of the USA) focus their swim programs for infants and young children around the concept of developing aquatic readiness and adjustment.

These programs intend to prepare children to acquire swim skills and strokes at later ages and ultimately to improve water safety.

The American Academy of Pediatrics (AAP) has issued several policy statements related to infant swimming that have cautioned against offering swimming lessons for infants and young children. The most recent policy statement (2003) recommends that all children learn to swim but continues to urge aquatic agencies and parents to restrict organized swimming lessons until after a child has reached the age of 4 years (48 months) "due to general developmental limitations" (AAP, 2000). Despite the AAP policy statements, the American Red Cross (1988; 1992; 2004; 2009) and YMCA of the USA (1987; 1999) along with other aquatic agencies offer infant aquatic programs for children beginning at around 6 months of age. Privately-sponsored swim schools and other programs (e.g., Infant Swimming Research; Infant Swimming Resources) offer swim lessons and "drownproofing" programs for infants at even younger ages.

There is abundant anecdotal and research evidence that individual infants and young children are capable of gradually acquiring developmentally primitive, but voluntary, aquatic behaviors at young ages, always sometime after the first birthday. Numerous aquatic practitioners have published popular press books encouraging the teaching of swimming to infants and young children and describing their personal techniques and methods (e.g., Clevenger, 1986; Newman, 1967; 1969; Shank, 1983). Margaret Mead noted that infants among aboriginal peoples in the South Pacific islands learned to swim at approximately the same age as they learned to walk on land (Mead, 1930), that is, during the second year of life. Myrtle McGraw (1935; 1939; 1945) provided substantial research information including excerpts from her research films about aquatic behaviors associated with human infants. McGraw's work (1939) illustrated that infant aquatic behaviors progressively changed from "reflexive swimming" and "disorganized phase" behaviors during the first year and led up to "voluntary swimming" during the first second year of life when a child is given regular exposure to the water. McGraw's work was documented on 16mm film that is still available. **Note**: *McGraw points out on the films that infants demonstrating reflexive, disorganized, and early voluntary phase swimming movements during the first two years of life are unable to raise their heads to breathe but must perform these movements for short periods of time while holding the breath. This suggests that prior to age two years, the developmentally primitive swimming behaviors have limited or no functional value relative to an infant surviving an unsupervised immersion incident because of the inability to get a breath.*

Erbaugh (1978; 1980; 1986) studied the acquisition of swimming among young children ages 2 to 5 years and published both cross-sectional and longitudinal findings. In conclusions parallel to McGraw's findings, Erbaugh noted that preschool children enrolled in twice-weekly "gym & swim" sessions gradually changed their aquatic skills both qualitatively and quantitatively according to regularly ordered developmental sequences. Interestingly, the majority of young children acquired the capacity to enter, swim a short distance, turn, swim back, and exit the water only after approximately 4.5 years of age, an age that roughly coincides with the observed reduction in the drowning rate at around 5 years of age. Of course, correlation should not be confused with causation, but these findings do suggest that maturational as well as experiential, psychomotor, and cognitive factors may all interact to explain the observed decline in the incidence of drowning rates during or after the fifth year of life.

In Germany, Diem (1973; 1982) conducted longitudinal studies of infants and young children enrolled in infant swimming (i.e., *kleinkinderschwimmen*) and gymnastics (i.e., *kleinkindergymnastik*) and their later performance at school age. She documented that children with early infant and preschool experiences in swimming and gymnastics performed much better academically in primary school compared to a control group. Unfortunately, she did not concurrently document whether the children at school age also demonstrated improved specific psychomotor skills such as in swimming.

Langendorfer and colleagues (Harrod & Langendorfer, 1990; Langendorfer & Willing, 1985; Langendorfer & Bruya, 1995; Langendorfer, Roberts, & Ropka, 1987) have documented that young preschool and elementary-school aged children are capable of acquiring a variety of basic aquatic skills (e.g., water entry, breath control, arm propulsive action, leg kicking action, combined locomotor skills) at developmentally rudimentary levels of coordination and control. They also demonstrated that young children acquire basic aquatic skills in regular, ordered sequences of change (e.g., downward, pushing arm motions precede longer, backward propulsive arm actions; pedaling leg actions precede flutter kick; dog paddling locomotor actions precede more advanced crawl locomotion), and that these basic aquatic skills (e.g., breath control, body position, arm and leg actions) can be assessed validly and reliably using qualitative assessment instruments (e.g., Aquatic Readiness Assessment (ARA) (Erbaugh, 1978, 1980; Langendorfer & Bruya, 1995). It is important to note that the basic aquatic skills each change developmentally over time and experience generally in parallel with each other rather than in a serial order.

The only researchers who specifically examined age as an independent research variable were Parker and Blanksby (1997). They examined relationships among age and the efficacy of acquiring water confidence and basic aquatic locomotor skills (but not formal strokes). The youngest ages for introducing swimming skills were not associated with the shortest acquisition period. Rather, children who began swim lessons at ages 4-6 years were observed to acquire rudimentary skills in the shortest absolute time period. Earlier experience was associated with somewhat improved levels of movement confidence, but the impact on actual coordination and control of swimming skills was not studied.

Asher and his colleagues (1995) found that young children approximately 3 years of age, in fact, demonstrated significant changes in their rudimentary aquatic behaviors (i.e., deck safety behaviors, recovery in water, jump and swim to side) after both 8 and 12 weeks of training when pre- and post-experience results were compared. They concluded that selected water safety experiences may play a role in promoting reduction in the incidence of drowning.

Brenner and colleagues (2003, 2009) have contributed two publications focusing on the role of swimming ability and lessons to drowning prevention. The first (2003) provided a review identifying the paucity of evidence associating swimming with reducing the risk of drowning. The recent publication (2009) was a case control study examining the impact of swim lessons and ability on the risk of drowning in children, ages 1-19 years, with 301 families matched on geography, SES and child age/sex and differing on whether a child member had drowned. Among children 1-4 years old, authors claimed 88% reduction in risk of drowning associated with children who had formal swimming lessons, but with 95% CI ranging from 3-99%.

Lifespan Developmental Literature

In the developmental literature, some authors have argued that *age* serves mainly as a convenient, but somewhat imprecise, "collective marker variable" against which to measure changes in behavior (Bronfenbrenner; 1979; Gibson, 1964; Newell, 1986; Roberton & Halverson, 1984; Wohlwill, 1973). From a conceptual developmental perspective, age crudely substitutes for other specific causal or relational variables that change over time. Roberton and Halverson (1984) distinguished between the concepts of "age-determined" and "age-related." They explained that "age-determined" notions identify behaviors as strictly correlated to an individual's age (i.e., when one knows a person's age, they can accurately identify that the individual should be able to perform a specified behavior). An "age-determined" perspective generally ignores the existence of variability in the age of acquisition for behaviors and presumes that changes primarily are caused by endogenous maturational factors. An age-determined maturational perspective claims that infants normally are expected to begin walking at 12-13 months of age. In contrast, an "age-related" perspective understands that behaviors are influenced by a variety of variables including genetics and experiences, that there is a non-causal, correlational relationship between the onset of any behavior and a person's age, and that there is a large degree of individual variability in the age at which behaviors may be acquired. For example, an "age-related" perspective recognizes that the "normal" age of onset for walking may have a 90% confidence interval of 9-18 months around a mean of approximately 13 months.

The concept of *developmentally appropriate practices* (DAP) likely reflects the most contemporary thinking related to the question of when to introduce individuals, especially infants and young children, to specific tasks or environments such as swimming lessons. The National Association for the Education of Young Children (NAEYC) (Bredekamp, 1996) was the first agency to propose the concept of "developmentally appropriate practices." According to NAEYC, DAP should be characterized as possessing twin components: *age appropriate* and *individually appropriate* practices. *Age appropriate* practices relate to general "screening" variables that may be relatively common to persons of a defined age range (while recognizing that all behaviors are "age-related," not "age-determined"). *Individually appropriate* practices are those which are influenced by variables and methods related to individual, or ontogenetic, behavioral differences and for which age poorly predicts performance with any precision. They recognize that certain behaviors are much less related to a person's chronologic age than to other psychomotor, cognitive, affective, or social variables. Associated with this review and its research questions, the concept of developmentally appropriate practices and developmental readiness may be productively applied to issues surrounding swimming skill acquisition and swim programs.

Roberton (1993) operationalized the concept of *individual developmental appropriateness* by defining the concept as a process by which a clinician matches the specific task to needs of any individual. To do this, she suggested that clinicians (e.g., swim instructors) require four instructional skills or attributes:

1) Skill in developmental assessment (i.e., in evaluating an individual's location along a developmental continuum associated with the behavioral dimension (i.e., a particular swimming skill) under consideration);

2) Skill to teach/interact with individuals even when those individuals were in groups (e.g., use indirect teaching techniques such as learning stations, small groups, peer teaching, task cards, or task setting);
3) Skill to alter the difficulty of tasks to be learned (i.e., to make tasks easier or harder, depending upon the needs of the individual by using techniques such as *developmental task analysis*, *constraints-based task analysis*, or *ecological task analysis*);
4) The appreciation that the curriculum (i.e., *what is to be taught*) is <u>not</u> sacred and must not be carved in stone, but needs to be modified to meet the needs of each individual learner.

Applied to the DAP issues of when, what, and how to teach swimming to young children, developmentally appropriate practices could extrapolate the following conclusions:

1) Swim instructors and parents need to have training and skill in assessing a child's cognitive and general psychomotor skills, and specific water readiness. These assessment skills should consider the degree to which the child enjoys the water, a relative appreciation for the risk associated with the water, and the ability to follow directions and adhere to minimum safety rules.
2) Aquatic instructional practices should be aimed at the needs of individual children in classes, not the class as a group. The size of classes should maintain instructor-student ratios associated with the ages and skills of participants.
3) Aquatic instruction should employ learner-centered indirect techniques that view skill acquisition from a systems perspective rather than either strict maturational or learning perspectives.
4) The flexibility of lesson plans and curriculum oriented toward student success must be given priority over a rigid progression of skill teaching. The lack of a demonstrated single best way to facilitate aquatic skill acquisition should reinforce the need for instructors to consider diverse methods of instruction that increase the probability of improved skill acquisition.

<u>Review Process and Literature Search Performed</u>

Performed a general literature review associated with "swimming," "age," "development," and "drowning" using Google Scholar, Nexus-Lexus, Medline, and PubMed. Number of "hits" exceeded 900 references/abstracts of mixed quality and application to this review.

The references also included theoretical developmental resources from personal library and Biomechanics/Motor Behavior Laboratory library and film collection, Bowling Green State University, Bowling Green, OH. Other references were located from references and citations of initial references.

Scientific Foundation for Minimum Age for Swim Lessons Evidence Review:

What scientific evidence exists to support setting a minimum age for swimming lessons?

The most recent AAP statements (2000; 2003) both called for a minimum age of 4 years before children should enroll in formal swimming lessons because "children are generally not developmentally ready…until after their fourth birthday." In holding to a minimum age, the AAP has implied that "developmental readiness" is primarily defined from a maturational, "age-determined" perspective. The statements fail to adequately define "developmental readiness" from the learning (experiential) and systems theoretical perspectives or acknowledge that research demonstrates many children in fact can and do learn to swim at ages younger than four years. While there is no evidence that aquatic experiences prior to the first year of age provide any longstanding, persistent benefits either to skill acquisition or to reduce the risk of drowning, the same cannot be said of experiences during the second, third, and fourth years of life.

The most recent AAP statement (2003) does acknowledge the existence of individual differences related to differing rates of learning, but primarily in a negative direction (e.g., some children who have disabilities may not be ready to begin formal swimming lessons until after age 4). The 2003 statement does not appear to recognize that as an "ontogenetic" skill, swimming skill acquisition may be significantly influenced by specific experiences (i.e., familiarity and experience in the water), not just individual rates of learning. Also, the statement ignores the bi-directionality of individual differences (i.e., if individual children may be delayed, others may in fact be ready earlier than four years for swimming lessons). In point of fact, chronologic age alone is a poor criterion upon which to base decisions about the appropriateness of beginning swimming experiences.

Virtually all learn-to-swim programs are based upon the use of prerequisite skill level (i.e., readiness) rather than age as the most appropriate criterion to make decisions about when and what children are ready to learn in the water. Obviously, the purposes for which the aquatic experiences are oriented determine an individual child's readiness and the prerequisite skills. Programs designed for providing aquatic readiness or aquatic therapy experiences certainly may be developmentally appropriate for infants, toddlers, and preschool children younger than four years of age. As suggested by the CNCA guidelines (1985), minimum prerequisites for introducing infants to the water environment should include prerequisite skills such as upright head and trunk control and ability to voluntarily maintain breath control. As suggested by McGraw (1945), Mead (1930), and Langendorfer & Bruya (1995), in order to begin acquiring basic aquatic locomotion (e.g., dog paddle or beginner stroke), toddlers and young children probably should have acquired independent sitting, standing balance and independent stepping. Swimming lessons designed for the purpose of acquiring formal swimming skills such as crawl stroke or for adequately preventing drowning require much more advanced prerequisite motor and cognitive skills including advanced dynamic postural and land locomotion (jumping, running, galloping) and ability to follow simple water safety rules and appreciate basic risks (McGraw, 1945; Langendorfer & Willing, 1985; Langendorfer & Bruya, 1995). Although a small group of "drownproofing" advocates might argue that rolling over and floating are sufficient to prevent drowning, there is absolutely no published evidence to support such an anecdotal claim and it is not in line with the historical developmental evidence (McGraw, 1939; 1945).

While not plentiful, the developmental research clearly indicates that

- many basic aquatic skills (e.g., voluntary breath control, water entry and exit skills, dog paddle) can be acquired between 18 and 60 months of age;
- basic aquatic skills acquired during the preschool period primarily serve a role as foundational or readiness skills for later and more advanced swimming skill and stroke acquisition;
- skills acquired during the 12-30 month period are largely ineffective as the primary means for learning strokes or preventing drowning.
- associated readiness skills (e.g., sitting, standing, walking, jumping on land plus developmentally earlier levels of basic aquatic skills) are more acceptable criteria for making individual decisions about starting aquatic experiences than age alone.

Despite this limited evidence, the answer to whether a minimum age for starting swimming lessons exists and, if so, at what age that could be remains a matter of strong differences of opinion in aquatics and medicine. The NAEYC emphasizes that parents are the first and best teachers of their children. By extension, it is incumbent upon aquatic and medical experts to provide parents with consensus evidence-based information so that parents may make informed decisions about when and what aquatic experiences their young child should receive. The use of the concepts of developmental readiness and developmentally appropriate practices hold promise for reframing the issue and possibly achieving a consensus among health care professionals and aquatic practitioners.

McGraw (1939) demonstrated that infants can acquire very rudimentary swimming locomotor skills such as face-in paddling in parallel to and approximately on the same time scale as they acquire terrestrial locomotor skills (e.g., creeping, standing, walking). As with terrestrial locomotion in which a child first takes one or two awkward steps, then toddles with outstretched arms, and only gradually acquires more adult-like control and coordination of walking and running, individual swimming skills change very gradually from early levels such as brief face entry, momentary or supported flotation, and front paddling to more advanced longer submersion and rhythmic breathing, extended flotation and rudimentary strokes. Erbaugh (1978; 1980; 1986) observed that most preschool children under the age of 4.5 years did not achieve sufficiently advanced levels of skill to swim 10-15 feet combined with entering and exiting the water. Asher et al. (1995) observed significant changes in 3 year old children after a water safety training program. Brenner et al. (2009) found that it was significantly more likely that children from control families where a drowning had not occurred had taken swim lessons and had swimming skill than in families where a drowning had occurred. She interpreted this as associated with an 88% reduction in risk of drowning among 1-4 year old children although the 95% confidence intervals ranged from 3% to 99%. Parker and Blanksby (1996) discovered that starting swim lessons at younger ages (e.g., four and five years) was not associated with the most efficient (shortest) acquisition period. Starting swimming lessons after age five produced more rapid skill acquisition.

Conclusion: The limited empirical research evidence does not support prohibiting early aquatic experiences at any specific age. At the same time, no evidence exists that children younger than 15-18 months acquire aquatic skills to any degree of water competence nor does this early experience provide any sufficient long term benefits. The limited evidence suggests that minimum proficiency is generally not acquired prior to 4.5 years old. The most appropriate objectives, skills, and methods for facilitating the achievement of such activities have received little or no empirical examination.

Does evidence exist to support an optimal age for acquiring swimming and aquatic skills?

McGraw (1935) demonstrated that earlier swimming experiences provided to one twin up through 23 months offered earlier and qualitatively superior acquisition of some motor skills including swimming during the second year of life compared to the control twin. It is important to note, however, that the control twin still acquired all the same skills, but at later ages and with somewhat reduced degrees of motor control. The motor milestones normally acquired during the first year of life were not influenced by early experiences. Diem (1982) provided evidence that swimming experiences during the first four years of life appeared to contribute to enhanced academic and psychomotor performance. The effect on school-age swimming skills was not studied closely. According to Parker and Blanksby (1996), the later preschool years appeared to provide the shortest acquisition time period for acquiring rudimentary swimming stroke proficiency. They did not study the quality of the swimming pattern, so it is possible that earlier experience may lend itself to improved control and coordination, as observed by McGraw.

Conclusion: Age does appear to interact to a limited degree with the efficiency of swimming skill acquisition. The choice of dependent variables studied seems to alter that conclusion. Based upon limited evidence, later preschool ages (4-6 years) appear to allow the most rapid acquisition of traditional swimming skills such as floating, rhythmic breathing, and crawl stroke. The later preschool years may represent an optimal age for introducing traditional learn-to-swim lessons (e.g., to acquire formal swimming strokes) if the goal is to maximize efficiency (i.e., in the shortest time period). The optimal age for introducing a child to the water for the purpose of providing aquatic readiness and water acclimation seems to be earlier ages (e.g., 1-4 years). An optimal age for starting water experiences to reduce the risk of drowning has not been studied, but the Asher et al. study suggests that some limited benefits may occur around age three years.

Does evidence exist to support a universal order of acquisition for swimming and aquatic skills?

Only two studies have focused on the order of skill acquisition and both employed Guttman's scalogram using convenience cross-sectional samples. Harrod & Langendorfer (1990) found that a number of Red Cross beginner swim items were presented in a less than optimal order. The most surprising result was that gliding and rudimentary paddling skills should be presented to children prior to presenting simple floating skills. Also, the use of a 10 second breath holding skill was the most difficult beginner skill. As a consequence, the Red Cross revised and re-ordered the skills associated with their beginner levels of learn-to-swim program (American Red Cross, 1992). Langendorfer, Chaya, and Swank (in press) examined a broader set of more advanced swimming items ranging from submersion and floating to formal strokes in a young adult sample. The order currently being used by the Red Cross (2004) produced the highest coefficient of reproducibility (i.e., 0.93). It is unclear whether these studies studying swimming behaviors of children and young adults apply to young children.

Conclusion: From the two limited studies, there is limited information about individual variability associated with the order of acquisition of aquatic skills. There does appear to be only minimal difference in the order in which items can be presented to elementary age children vs. adults, but at least some children seem to benefit from learning gliding and paddling skills prior to floating. Adults appear to acquire skills in the more traditional order of floating followed by gliding and paddling.

Children also found extended breath holding (i.e., 10 seconds) to be much more difficult than did young adult beginners.

Does evidence exist to identify the most appropriate purposes and methods for aquatic programs for young children?

The issue about the most appropriate purposes and methods for infant and young child aquatic programs represents a very controversial and poorly studied area. As identified earlier, at least four program purposes exist in aquatic programs for infants and children: 1) create "drownproofing" skills as the primary drowning prevention strategy; 2) develop aquatic readiness skills in preparation for learning later skills; 3) promote precocious acquisition of skills for competitive swimming development and survival; and 4) use water as a therapeutic environment. No current research exists that compares or contrasts these purposes or their relationship to age or readiness. Understanding the appropriateness and effectiveness of different purposes for young child aquatic programs is an important area for future research.

Only one study, a doctoral dissertation (Illuzi, 1990), has examined the effectiveness of different methods of teaching swimming. Illuzi found that no significant differences in the degree of aquatic learning among preschoolers when taught by traditional, direct methods (i.e., command style) versus indirect, guided discovery methods. The indirect teaching method provided more learning time than the direct teaching method, but the improvement in swimming skills was similar across the techniques. Several important questions need to be addressed through larger, prospective studies. Are some swim program purposes more or less appropriate than others? Are some methods more effective than others for achieving different lesson purposes? Specifically, what appropriate roles should parents play in children's swimming programs? Are some methods more appropriate for different skill and age groups?

Summary:

The longstanding tradition for swimming lessons to use criterion-referenced approaches (i.e., focus on existing skill level to predict what to learn next, a.k.a., readiness) remains the most appropriate way to make decisions about when individual children are ready to begin aquatic experiences and what skills they should learn. The literature contains little definitive research to either restrict swimming experiences to the *minimum age* of fours years as promoted by AAP or to necessitate early experience in swimming. Some limited research (e.g., McGraw, Diem) suggests that regular, persistent experiences across the preschool period provide some longer term qualitative aquatic benefits. A single study by Parker and Blanksby suggested that starting swim lessons between the ages of 5-6 years resulted in a shorter period of skill acquisition than starting at young ages. The review indicated the need for additional larger prospective studies to be conducted to address issues and questions related to efficiency, optimality, quality, readiness, and appropriate pedagogy for swimming skill acquisition by young children.

Recommendations and Strength (using table below):

Standards: None

Guidelines: None

Option: Class III. The limited research evidence demonstrates that

- Individual infants and young children are capable of acquiring selected basic aquatic skills during the first two to five years of life at a rudimentary level of development/proficiency;
- No evidence exists that learning voluntary aquatic skills prior to 15-18 months of age produces a functional level of proficiency or advantage in preventing drowning;
- Limited evidence exists that early introduction to swim lessons (i.e., prior to age 4 years) may provide some drowning prevention benefits;
- There is no research evidence to suggest that early swimming lessons increase the likelihood of drowning;
- The research evidence related to issues of program purpose/outcomes, functionality of skills, developmental level, or degree of competence, efficiency of acquisition, and methodology for that acquisition process is insufficient to support either a standard or guideline relative to a minimum age or other criteria;
- Based on the consensus of major aquatic agencies and experts, infants and young children between the ages of 2 and 4 years can optionally start swim lessons for the purpose of building aquatic readiness and water acclimation on an individual basis. Individual considerations in addition to age should include child-specific cognitive, social, and psychomotor readiness factors including prerequisite skills such as voluntary breath control, upright head and trunk righting, upright balance, and independent walking.

The preponderance of expert opinion supports the following:

- Learning to swim, while *eventually* an important factor in reducing the risk of drowning, is neither an adequate nor sufficient means for preventing drowning especially among children younger than four-five years.
- Drowning prevention requires multiple layers of redundant preventive steps including adequate four-sided fencing with self-latching gates as well as childproof locks on all external doors and windows from the residence. The most important factor in preventing child drowning must be constant appropriate active supervision of all children. Qualified active supervision is defined in a separate statement.
- Water safety education for children at all ages and their parents/guardians must be an integral component of all aquatic programs as a means to facilitate water safety and drowning prevention.

Because these final three statements were peripheral to the questions addressed in this review, a separate scientific review will be conducted to identify appropriate levels of evidence for them. For all of the above options, additional focused, prospective research must be conducted to address whether these expert opinions merit reclassification as guidelines.

Class	Description	Implication	Level of Evidence
I	Convincingly justifiable on scientific evidence alone.	Usually supports Standard	One or more Level 1 studies are present (with rare exceptions). Study results consistently positive and compelling
II	Reasonably justifiable by scientific evidence and strongly supported by expert opinion.	Usually supports Guideline but if volume of evidence is great enough and support from expert opinions is clear may support standard	Most evidence is supportive of guideline. Level 1 studies are absent, or inconsistent, or lack power. Generally higher levels of evidence. Results are consistently supportive of guideline.
III	Adequate scientific evidence is lacking but widely supported by available data and expert opinion. Based on	Usually supports Option.	Generally lower or intermediate levels of evidence. Generally, but not consistently results are supportive of opinion.
IV	No convincing scientific evidence available but supported by rational conjecture, expert opinion and/or non peer-reviewed publications	Usually does not support standard, guideline, or option. Statement may still me made which presents what data and opinion exists. In some cases and in conjunction with rational conjecture may support option.	Minimal evidence is available. Studies may be in progress. Results inconsistent, or contradictory.

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

Author(s)	Full Citation	Summary of Article	Level of Evidence
American Academy of Pediatrics	American Academy of Pediatrics. (2003). Policy statement: Prevention of drowning in infants, children, and adolescents. *Pediatrics, 112*(2), 437-439.	AAP policy statement from the Committees on Sports Medicine and Fitness as well as on Injury and Poison Prevention that argues for no organized, formal swimming instruction for children younger than 4 years "for developmental reasons."	Level 5
American Academy of Pediatrics	American Academy of Pediatrics. (2003). Policy statement: Prevention of drowning in infants, children, and adolescents. *Pediatrics, 112*(2), 437-439.	AAP policy statement from Committee on Injury, Violence, and Poison Prevention expands upon the previous statement with a series of age-related recommendations for infants and children through 4 years, children 5-12 years, and adolescents 13-19 years. It recommends that children 5 years and older need to be taught to swim for water safety and drowning prevention reasons. It maintains prohibition on formal swimming lessons for children less than 4 years of age. It does introduce the concept of individualization for when to start swimming lessons.	Level 5
Asher, Rivara, Felix, Vance, & Dunne	Asher, K.N., Rivara, F.P., Felix, D., Vance, L., & Dunne, R. (1995). Water safety training as a potential means of reducing risk of young children's drowning. *Injury Prevention, 1*(4):228-33.	This sample of 109 young children (~35.2 mos) tested pre- and post- water safety training experiences of 8 or 12 weeks. Significant changes were observed for deck safety behaviors, recovery in water, and jump and swim measures. Authors concluded need to do more studies, but water safety training potentially reduced drowning.	Level 3b
Brenner, Saluja, & Smith	Brenner, R.A., Saluja, G., & Smith, G.A. (2003). Swimming lessons, swimming ability, and the risk of drowning. *Injury Control and Safety Promotion, 10*(4), 211-216.	Article reviews the limited evidence regarding the positive relationships among swimming ability, swim lessons, and risk of drowning. It also reviews recommendations for swimming instruction and needs for future research.	Level 5
Brenner, Taneja, Haynie, Trumble, Qian, Klinger, & Klebanoff	Brenner, R.A., Taneja, G.S., Haynie, D.L., Trumble, A.C., Qian, C., Klinger, R.M., & Klebanoff, M.A. (2009). Association between swimming lessons and drowning in childhood. *Archives of Pediatric and Adolescent Medicine, 163*(3), 203-210.	A case control study that estimated the association between swimming lessons and the risk of drowning among children 1-19 years. Families who had experienced a child drowning were interviewed and compared to control families with not children drowning. Admittedly imprecise results found 88% reduction in risk of drowning among 1-4 year olds associated with having taken swim lessons with a 95%	Level 2a

		CI from 3%-99%.	
McGraw, M.B.	McGraw, M.B. (1975/1935). *Growth: A study of Johnny and Jimmy*. New York: Arno.	Co-twin case study illustrated that experimental twin could achieve rudimentary front locomotion during first twenty-three months of life with regular experience	Level 2b
McGraw, M.B.	McGraw, M.B. (1939). Swimming behavior of the human infant. *Journal of Pediatrics, 15*(4), 485-490.	Identified three phases of rudimentary swimming behavior through which infants and young children passed.	Level 2b
McGraw, M.B.	McGraw, M.B. (1945/1963). *Neuromuscular maturation of the human infant*. New York: Hafner.	Book overviews a wide variety of developmental changes in infant motor behavior including swimming phases (see McGraw, 1939).	Level 5
Erbaugh, S.J.	Erbaugh, S.J. (1978). Assessment of swimming performance of preschool children. *Perceptual and Motor Skills, 47*, 1179-1182.	Study identified a developmental instrument for assessing aquatic skills in preschool children.	Level 2b
Erbaugh, S.J.	Erbaugh, S.J. (1980). The development of swimming skills of preschool children. In C. Nadeau, K. Newell, G. Roberts, & W. Halliwell (Eds.), *Psychology of motor behavior and sport-1979* (pp. 324-335). Champaign, IL: Human Kinetics.	Initial report of some cross-sectional age differences in swimming skills observed among pre-school children enrolled in twice-weekly gym-swim program.	Level 2b
Erbaugh, S.J.	Erbaugh, S.J. (1981). The development of swimming skills of preschool children over a one and one-half year period. *Dissertation Abstracts International, 42*, 2558A.	Dissertation demonstrating developmental changes in swimming skills among preschool children, aged 2-4.5 years.	Level 2b
Erbaugh,S.J.	Erbaugh, S.J. (1986a) Effects of aquatic training on swimming skill development of preschool children. *Perceptual and Motor Skills, 62*, 439-446.	Peer-reviewed version of Erbaugh dissertation (1981).	Level 2b
Langendorfer et al.	Langendorfer, S.J., Roberts, M.A., & Ropka, C.R. (1987). A developmental test of aquatic readiness. *National Aquatics Journal, 3*(2), 8-9, 12.	Study using videotaped observations of developmental differences in arm and leg actions and body position in swimming among young children.	Level 3b
Langendorfer & Willing	Langendorfer, S.J., & Willing, E. (1985). The impact of motor development research upon issues in infant and preschool aquatics. *National Aquatics Journal, 1*(1), 14-15.	Overview article integrating previous motor development research related to swimming to recommendations about swimming instructional programs.	Level 5
Harrod & Langendorfer	Harrod, D.K., & Langendorfer, S.J. (1990). A scalogram analysis of the American Red Cross Beginner swimming skill items. *National Aquatics Journal, 6*, 10-16.	Scalogram analysis (Guttman, 1950) that identified "best order" for presenting beginning swimming skills to children. Used as one basis for altering the Red Cross swimming levels in 1992.	Level 2a
Langendorfer, Chaya, &	Langendorfer, S.J., Chaya, J., & Swank, K. (in press). Scalogram analysis of the order for selected swimming skills. *International Journal*	Study examined the robustness of the order of acquisition of 13 swimming skills in college-age young adults. The order of	

Swank	*of Aquatic Research and Education,*	acquisition was similar to that already used in the American Red Cross learn-to-swim program for children.	Level 2a
Parker & Blanksby	Parker, H.E., & Blanksby, B.A. (1997). Starting age and aquatic skill learning: Mastery of pre-requisite water confidence and basic aquatic locomotion skills. *The Australian Journal of Science and Medicine in Sport, 29*(3), 83-87.	This only study the explicitly examined the relationship of starting age and the efficacy with which children acquired rudimentary aquatic skills and water confidence. Later preschool age was the most efficacious age at which to begin lessons on the basis of time to acquire a basic level of competency.	Level 2a
Council for National Cooperation in Aquatics	Council for National Cooperation in Aquatics (1985). Guidelines for infant and preschool swim programs. *National Aquatic Journal, 1*(2), 11-12.	This published version of the CNCA guidelines modified several earlier versions and provided a rationale for each of the 10 guidelines.	Level 5
American Red Cross	American Red Cross (1988). *Infant-Preschool Aquatic Program manual*. St. Louis: Mosby. [(2004). Water safety instructor manual. Yardley, PA: Lifeline.]	This was the first instructional materials published by the American Red Cross on a national level oriented toward infant and preschool swimming readiness programs. [2004 version is contemporary reference and program is currently called "Parent-Child Program."]	Level 6
YMCA of USA	YMCA of USA (1987). *Y Skippers Program Manual*. Champaign, IL: Human Kinetics (Y Program Store) [1999 is most contemporary version of program offered by YMCA.]	The Y Skippers program was the first published official national aquatic instructional program for infants and young children. It expanded upon a previous parent-child program "1, 2, and You." Like the Red Cross IPAP program, it focused on developing aquatic readiness skills; unlike the Red Cross IPAP program, Y Skippers was more closely integrated with the Y Swim Lessons for older children, particularly in 1999 version.	Level 6
Newman, V.H.	Newman, V.H. (1967). *Teaching an infant to swim*. New York: Harcourt Brace & Jovanovich. Newman, V.H. (1969). *Teaching young children to swim and dive*. New York: Harcourt, Brace, & World.	This was the first published text to illustrate how infants could be taught to swim. The author claimed that an infant could learn to swim (i.e., dog paddle) with 100 hours of instruction. Second text describes Newman's instructional techniques with preschool children.	Level 6

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	Prospective, controlled, non-randomized, cohort or case-control studies
Level 2b	Historic, non-randomized, cohort or case-control studies
Level 2c	Case series: 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.

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