UP-H2O

A Device for Upright Posture in Water

Student: Joshua Breighner
(breighner@hartford.edu)

Advisors: Dr. Sandra Saavedra
(saavedra@hartford.edu)

Dr. Donna Snowdon
(snowdon@hartford.edu)

PROBLEM STATEMENT/RESEARCH QUESTION AND BACKGROUND

Developing the ability to sit with an upright head and body is essential to various activities and subsequent levels of participation for children and adults. Providing children with appropriate postural contexts in the home or community allows them to communicate and interact with their environment. Children who have deficits in trunk control are likely to have decreased visual input, communication, and use of their extremities in various activity-based settings. For these children success is closely linked to the amount of support they are provided, which occurs most often by various assistive devices or specialized seating and positioning systems. Recent work from our research lab has shown that even children who lack head control can improve their upright ability with individualized external support at the right level of the trunk.[1,2,3]

Traditional therapeutic interventions for people who lack or present with deficits in trunk control primarily focus on comfort and prevention of secondary impairments. Failing to provide children with affordances associated with upright posture limits potential movement and participation benefits that therapeutic interventions typically provide. This paradigm can be observed in traditional aquatic therapy for children who present with moderate to severe developmental disabilities, which typically consists of a neck floatation device with direct contact/support from the treating therapist. Numerous studies regarding aquatic therapy for children with cerebral palsy exclude or do not recruit non-ambulatory children, indicating a lack of effective treatments for this population.[4,5]

Many children enjoy being in the water, potentially due to the unweighting properties and soothing effects; however, without upright posture to give children autonomy of their movements and time for interactions in the pool setting, there is a glass ceiling on the potential multi-system benefit. The purpose of this study is to develop a device capable of maintaining children in upright posture in water without the need for direct therapist contact. The device is intended to give children autonomy of movement and improve postural alignment in the water. Secondary outcomes of extremity movement and participation in the water will be studied to quantify the positive effects of the device and demonstrate its efficacy for this population. The device will be implemented on children with moderate to severe developmental disabilities with a focus on non-ambulatory children due to the disparity of options for active participation in aquatic therapy and lacking evidence regarding best practice for this population. We anticipate that it will shift the course of aquatic therapy towards a more autonomous and inclusive experience for this population.

METHODS/APPROACH/SOLUTIONS CONSIDERED

Initial designs for this device consisted of two "pontoons" (*see Figure 1)* on either side of the child that would enable the child to interact with the environment in front of them while maintaining upright posture in the water. The device quickly adjusted to an (almost) enclosed frame that remained open in front of the child to still allow them to play with their peers and the treating therapist. It became evident that the floatation frame would have to be connected to the child comfortably and in a way that allowed for adjustments of the frame to accommodate different children. Designing a device for this purpose requires significant considerations for the physical characteristics of the children in this population.

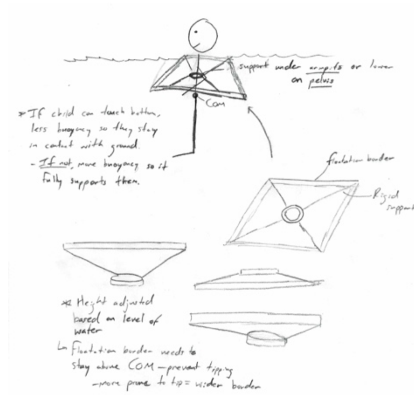

Figure1: Preliminary Design Drawings

Dr. Saavedra's use of the segmental approach to refine postural contexts guided the design process for how to attach the design frame to the children in this study. Using the Segmental Assessment of Trunk Control (SATCo), manual support is provided in a cephalocaudal direction at various segments of the spine to determine the level at which a child can no longer control their trunk.[3] The segments of support begin under the shoulders and progress before progressing inferiorly to assess at the upper/middle/lower ribs and the waist and pelvis. Independent sitting would be assessed if the child is able to control all other segments assessed. After establishing their level of trunk control through the SATCo, the device will be attached at the lowest level where the child demonstrates trunk control to allow the child to develop in this new environment with adequate support. This support encourages the child to actively maintain upright posture at the segments they have already developed control, and the device with the assistance of ankle weights will allow for upright posture caudal to this support. Additional baseline measurements prior to fitting the device will include quantifying extremity movement and overall engagement in a traditional aquatic therapy session (or prior participation level in a pool) to examine how the implementation of the device will improve the desired outcomes.

After the initial data collection, two additional sessions will be used to fit the child for the device/provide necessary postural contexts and observe improvements in the desired outcomes. Necessary adjustments to the fit of the device can be completed at the third and final visit. Data collections are expected to take 60 minutes and will involve 15 to 30 minutes of in-water play. The Dimensions of Mastery Questionnaire (DMQ-18) will also be utilized throughout the study to track the child's motivation in the device.

DESCRIPTION OF FINAL APPROACH AND DESIGN

The final design of the device was recently tested to collect pilot data on a typically developing child, and necessary changes were made to the device prior to this data collection to increase the child's stability in in the device and to create an adjustable frame that can be used for all children in the study. A strapping system was added to the device to circumferentially stabilize the child (pictured in black), and a pelvic strap (pictured in blue) was added to prevent the child from slipping further into the device. Velcro was added to the lateral supports on the device that also help to stabilize the child, who will be wearing a Velcro sensitive neoprene garment. The device was made adjustable with the integration of shortened pool skimmers to the posterior portion of both the trunk support and the floatation frame. This allows the frame to be expanded or collapsed to accommodate for the child's trunk width and desired level of support.

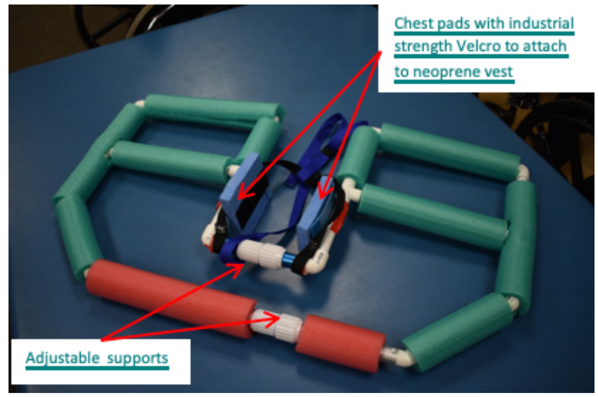

Figure 2: Current Design with adjustable supports

Fitting the child for data collections will require two researchers/family members. The child will be handed to a researcher or parent already in the water. They will support the child upright in the water with the desired level of trunk support resting at the level of the water while the other researcher attaches the floatation device by expanding the frame and collapsing in medially once the child is fully in the frame. Both researchers will remain in contact with the child/device until the child is determined to be stable in the water. The researchers will remain within arm's reach of the child for the entire data collection. Multiple camera angles, including an underwater camera, will be used to document the child's behavior.

This device is anticipated to enable all children, regardless of the severity of their impairments, to develop autonomy of movement and enjoy water recreation in a way that was not previously possible. Additions will be made to the device based on specific needs of the child. For children who lack head control, we would add an upright pad behind the head so that the child can actively raise their head and a floatation tray for arm support that will also prevent the child from inhaling or swallowing water while playing in the device.

OUTCOME (RESULTS OF ANY OUTCOMES TESTING AND/OR USER FEEDBACK)

Recent pilot testing was conducted without subsequent data processing. A typically developing child was recruited to test the stability, buoyancy, and fit of the device. Testing was conducted at the University of Hartford Sports Center with the child's guardian present along with four researchers. The child was eight years old and was able to advise researchers on the fit of the device and areas that needed to be adjusted. The same protocol described for children with developmental disabilities for fitting the device was performed. The child was supported by his guardian in the pool, and another researcher fit the device around the child from behind the child. Necessary adjustments were made to the width of the device, and it was easily secured with the twist mechanism on both the trunk support and the posterior border of the floatation frame. The child was stable in the device once all buckles were fastened. Testing was conducted with and without ankle weights; the ankle weights aided in the maintenance of upright posture in the water. The stability of the device was tested by having the child lean forward and backward to simulate a child who lacks trunk control. The device deviated more anteriorly but remained stable and afloat in both directions.

Figure 3: Pilot testing of the UP-H_2O device

Based on child feedback at the end of the data collection, a pool noodle will encase the pelvic strap so the child will sit on. The floatation will also be extended anteriorly for upcoming data collections to increase anterior stability. Despite minor changes, the pilot testing served as proof of concept for the current design. The child tested the device with passive prolonged postures and significant movements with little deviations in the stability of the device. Although the frame filled with some water during testing, the buoyancy of the device did not change over the course of the trials.

Future pilot testing will include execution of the full protocol and subsequent behavior coding for extremity movement and participation in in-water activities. The child was able to play with researchers while in the device, which would have required significant energy requirements to stay afloat without the device. The child was able to perform unrestricted lower extremity movements with ankle weights during the testing. Observations of the child who is typically developing in the device are promising for success in the target population. Adjustments will be made based on variable participant presentation.

COST (COST TO PRODUCE AND EXPECTED PRICING)

The current device cost approximately 75 dollars in supplies. The accessibility of the materials and low cost of all materials allows for necessary adaptations to be made to the original device for each child. The design is not expected to significantly change aside from the addition of a headrest or tray if necessary. These changes are expected to result in a total cost of $125-150. For the purpose of this study, the current design will be utilized for a majority of the participants and adapted as needed. The design's simplicity is intentional to promote ease of use and minimal cost. Further development of this device will be considered following the completion of this study.

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- University of Hartford Sports Center—for allowing pilot data collections to be performed at the University Pool

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