Air Medical Journal ■■ (2018) ■■–■■

Contents lists available at ScienceDirect

Air Medical Journal

journal homepage: http://www.airmedicaljournal.com/

Original Research

Drones for Provision of Flotation Support in Simulated Drowning

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A B S T R A C T

Objective: The feasibility and potential of using drones for providing flotation devices in cases of drowning have not yet been assessed. We hypothesize that a drone carrying an inflatable life buoy is a faster way to provide flotation compared with traditional methods. The purpose of this study is to explore the feasibility and efficiency of using a drone for delivering and providing flotation support to conscious simulated drowning victims.
Methods: A simulation study was performed with a simulated drowning victim 100 m from the shore. A drone (DJI Phantom 4; dji, Shenzhen, China) equipped with an inflatable life buoy of 60 N was compared with traditional surf rescue swimming for providing flotation. The primary outcome was delay (minutes:seconds).
Results: A total number of 30 rescues were performed with a median time to delivery of the floating device of 30 seconds (interquartile range [IQR] = 24-32 seconds) for the drone compared with 65 seconds (IQR = 60-77 seconds) with traditional rescue swimming ($P < .001$). The drone had an accuracy of 100% in dropping the inflatable life buoy < 5 m from the victim, with a median of 1 m (IQR = 1-2 m).
Conclusion: Using drones to deliver inflatable life buoys is safe and may be a faster method to provide early flotation devices to conscious drowning victims compared with rescue swimming.

The World Health Organization estimates that about 400,000 individuals lose their lives in accidental drowning globally each year; the majority of the victims are younger than 25 years of age.[1] The drowning chain of survival (Fig. 1) states that preventative measures and the provision of flotation are key elements to prevent submersion and that safe rescue and resuscitation skills should be taught to bystanders.[2,3]

If drowning occurs, more than 10 minutes of submersion is associated with a low chance of survival.[3] Although water temperature is not a general predictor for outcome,[4] rare case reports have shown neurologically intact survival after prolonged submersion, primarily in children with initial hypothermia before asphyxia.[5-7]

Out of 137 accidental drownings reported from the Swedish Life Saving Society in 2014, a majority occurred during the summer season, with 36% in public bathing areas.[8] Data from the United Kingdom show that a majority of rescues (79%) at patrolled ocean beaches are performed within 50 m from the shore.[9]

Rip currents may represent a real hazard and are a common factor in which a rescue effort is needed.[10] Heavy surf conditions with high waves, rip currents, or breaking ice at lakes during winter may present with specific problems and prolonged response times during rescue, and rescuers may themselves be in danger in terms of hypothermia or even drowning.[11]

Therefore, more effective strategies are needed to facilitate earlier provision of flotation support, potentially feasible in highly populated beaches patrolled by lifeguards or in conditions with heavy weather and rip currents. The use of unmanned aerial vehicles, commonly called drones, may be used as a novel method for early search and rescue. A drone may be used to localize a submerged drowning victim using live video stream to a tablet[12] but also to transport an automated external defibrillator[13] or other medical or lifesaving devices.[14] Knowledge of wind, flight endurance, payload, and regulations needs to be ensured for the safety of using drones.[15]

The feasibility and potential of using drones to provide flotation support to conscious victims during drowning accidents, thus perhaps preventing drowning, has not yet been evaluated. In this

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1067-991X/$36.00

https://doi.org/10.1016/j.amj.2018.01.007

Figure 1. The drowning chain of survival. (Reprinted with permission; D. Szpilman, personal communication, October 2017.[2]).

study, we hypothesize that the response time of a drone launching from shore delivering an inflatable life buoy 100 m out to sea is faster than that of traditional surf rescue methods using rescue swimming and rescue boards. A drone has the potential to transport and deliver an inflatable life buoy by dropping it to the surface in order to provide early flotation and prevent submersion. The aim of this study is to explore the feasibility and efficiency of using a drone for delivering and providing flotation support to conscious simulated drowning victims compared with traditional surf rescue swimming.

Methods

Study Design

A simulation study was performed at Tylösand beach in Sweden in August 2017. The provision of flotation[3] was evaluated with a primary focus on the time from the start at the beach to the provision of flotation in water using the drone (intervention). This was compared with the trained response from a surf lifeguard using primary equipment (ie, rescue swimming and a torpedo buoy [control]). Secondary drone rescue was compared with the response time when using a surf rescue board (Fig. 2).

The Tylösand Surf Lifesaving Club uses an open beach patrol system without flags for guiding the public where to swim. The beach stretches for 6 km from north to south with 6 surf lifeguards patrolling the area between 10:00 AM and 18:00 PM during mid-June to mid-August each year, 56 patrolled beach days annually.

The drone, a surf rescue swimmer, and a lifeguard using a rescue board were positioned at the shoreline at Tylösand beach and were simultaneously dispatched to provide flotation for a total of 30 simulated test flights/runs. With a life buoy for safety, the simulated victim (a lifeguard) was placed at a predefined distance from shore (ie, 100 m, 2-m deep), thus awaiting assistance in terms of flotation support. The drone was remotely operated within the visual line of sight to provide flotation by dropping an inflatable life buoy while hovering in air above the victim. Via live video feed, the drone pilot could navigate and accurately drop the self-inflatable life buoy. The accuracy of drone delivery (meters) was documented as well as the response time from drone provision of flotation and physical contact from the rescue swimmer and rescue board. The primary end point was the time from the start at the beach to the provision of flotation to the simulated victim at 100 m (minutes:seconds) in 30 tests.

We hypothesized that the median response time from shore (0 m) and 100 m out to sea could be half of 83 seconds as shown in previous data[16] to 41 seconds (sample size, N = 30/cohort, 95% power, $\alpha = .05$).

Drone and Inflatable Buoy

A DJI Phantom 4 standard drone (dji, Shenzhen, China) was used for these test flights. The drone had a maximum estimated flight time of 25 minutes without payload. The drone was equipped with a 12-megapixel camera with a fixed 2.8-mm lens and a 94° field of view sending live video (1,280 × 720 pixels) to an iPhone 6 Plus

Figure 2. Rescue equipment from left to right: a drone equipped with an inflatable life buoy (intervention), a torpedo buoy for rescue swimming (control), and a rescue board for paddling.