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Clinical paper

Unmanned aerial vehicles (drones) to prevent drowning☆

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ABSTRACT

Background: Drowning literature have highlighted the submersion time as the most powerful predictor in assessing the prognosis. Reducing the time taken to provide a flotation device and prevent submersion appears of paramount importance. Unmanned aerial vehicles (UAVs) can provide the location of the swimmer and a flotation device.
Objective: The objective of this simulation study was to evaluate the efficiency of a UAV in providing a flotation device in different sea conditions, and to compare the times taken by rescue operations with and without a UAV (standard vs UAV intervention). Several comparisons were made using professional lifeguards acting as simulated victims. A specifically-shaped UAV was used to allow us to drop an inflatable life buoy into the water.
Results: During the summer of 2017, 28 tests were performed. UAV use was associated with a reduction of time it took to provide a flotation device to the simulated victim compared with standard rescue operations ($p < 0.001$ for all measurements) and the time was reduced even further in moderate (81 ± 39 vs 179 ± 78 s; $p < 0.001$) and rough sea conditions (99 ± 34 vs 198 ± 130 s; $p < 0.001$). The times taken for UAV to locate the simulated victim, identify them and drop the life buoy were not altered by the weather conditions.
Conclusion: UAV can deliver a flotation device to a swimmer safely and quickly. The addition of a UAV in rescue operations could improve the quality and speed of first aid while keeping lifeguards away from dangerous sea conditions.

Introduction

Drowning is still a leading causes of unintentional death worldwide [1]. Unintentional drowning occurs in diverse locations (lakes, rivers and coastlines), different weather conditions and affects adults as well as children. A clear picture of drowning is therefore challenging to brush. Despite this heterogeneity, a recent meta-analysis on drowning outcome at the scene has emphasized the importance of rapid care factors as short submersion durations (< 5 min) and short Emergency Medical Service (EMS) response times (< 9 min) [2]. Consequently, submersion time seems to be the most powerful predictor in assessing the prognosis of drowning [2–6]. This highlights the importance of prevention and early reaction in the drowning process [7]. A unique and “universal Drowning Chain of Survival” has been recently proposed to guide the life-saving steps for lay and professionals rescuers [8]. To match these results and recommendations [2–6,9], most bodies of water open to the public and offering watersports in France are supervised by lifeguards.

After the recognition of victim distress and call for help, the next priority is to interrupt the drowning process by providing flotation to the victim [8]. Nevertheless, sea condition, currents and wave size could interfere with rescue operations especially on the sea coast. Providing a flotation device using a drone equipped with an inflatable life buoy could be a new way to reduce the time taken by lifeguards to get a flotation device to the swimmer, particularly in difficult conditions. Drones have previously been reported as having the potential to transport an Automated External Defibrillator (AED) in case of Out of Hospital Cardiac Arrest (OHCA) before the emergency medical services arrive [10]. Drones may also have the potential to reduce the time taken to provide cardio-pulmonary resuscitation in drowning related OHCA by their recognition and alert ability [11] though not by a direct intervention yet.

The aim of this simulation study was to evaluate the efficiency of a drone in providing the location of a drowning victim and dropping an inflatable life buoy into the water. This test was performed and compared with standard rescue operations in different locations and under different sea conditions on the Atlantic coast of France.

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at https://doi.org/10.1016/j.resuscitation.2018.04.005.

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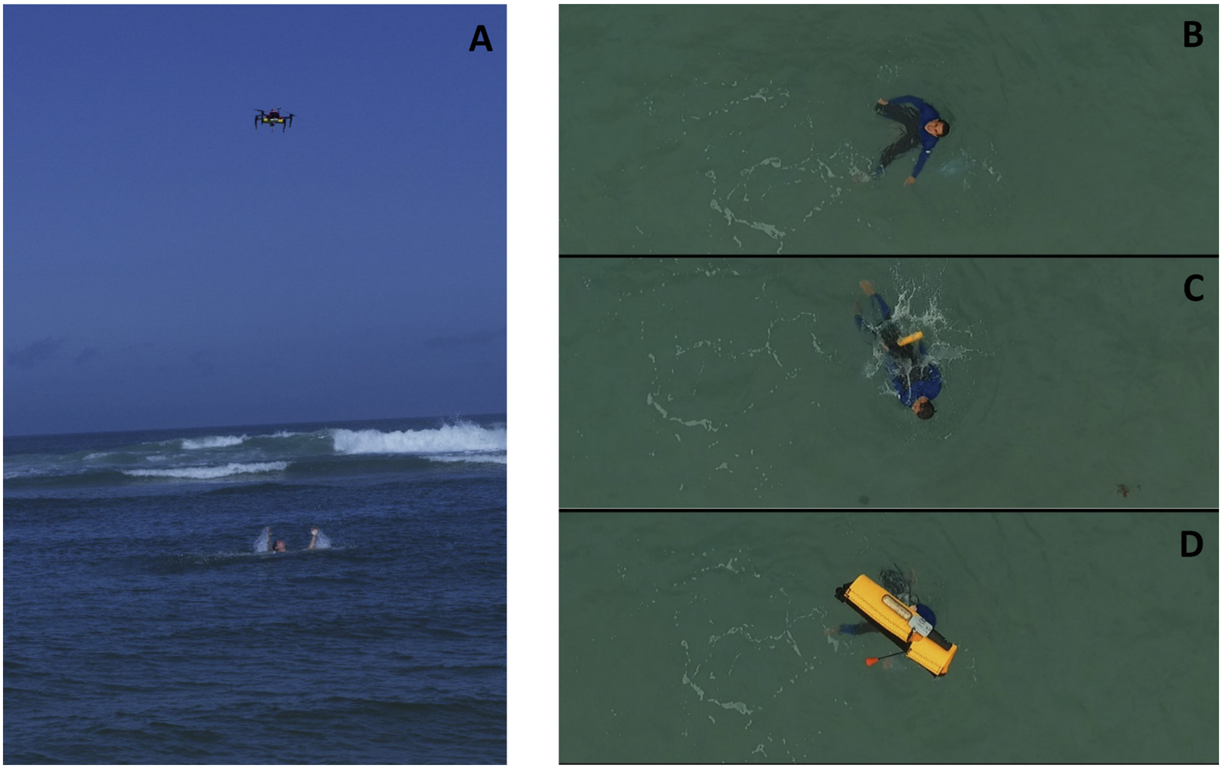

Fig. 1. Unmanned Aerial Vehicle (UVA) patrol intervention.
A: Unmanned Aerial Vehicle (UVA); B: Simulated victim; C: Drop life buoy; D: Inflatable life buoy

Methods

This is a prospective simulation study comparing two methods for locating a simulated drowning victim and providing them with a life buoy. This study was conducted on three beaches of the Atlantic coast of France in different sea conditions. All tests were performed during daylight over two months – July and August 2017.

Conditions on the Atlantic coast of France

The Atlantic coast of France mainly consists of a 200 km beach stretching from the Gironde estuary to the Spanish border. Although the sea temperature is warm – between 18 and 24 °C in the summer period – the coast is subject to currents and large waves. Moreover, the effects of the current on this particular area of beach create dangerous pools of water called "baïnes". Each summer, these conditions cause dozens to drown. All sea conditions were recorded during the tests. The calm, moderate and rough conditions have been defined according to the French legislation for beach security. These levels mainly depend on tide, swell size and wind and the local authority for beach security chose the level each morning in summer period.

In order to mimic real conditions, no weather restrictions were set as the lifeguards considered that the beach was open to swimmers. Sea conditions were categorized as calm, moderate and rough.

Test scenario

For each test, a simulated victim (lifeguard) chose a position in the sea at different distances from the beach (between 100 and 200 m), within a predefined search area of 50000 m^2. This area reflects the standard 'swimming allowed' area for a lifeguard team during the summer period. The distance from the beach was chosen as reflecting the most frequent location of drowning related to rip currents and baïnes in French Atlantic coast conditions. The other lifeguards were blinded to the location of the simulated victim and the alarm was rung by one of the doctors taking part in the study. The doctor and a lifeguard recorded the time between the alarm being rung to the life buoy being received by the simulated victim. Following this, two strategies were compared and analyzed.

All the lifeguards involved in this study were specifically trained police lifeguards and were not told that the study results would be analyzed or published to ensure rescue conditions would remain as close to standard rescue as possible. These lifeguards usually took part in beach patrol every year, and had done so for several years.

Standard rescue operation by lifeguards (SRO)

Each lifeguarding team was composed of one lifeguard located at the bottom of the sand dune who looked for the victim using binoculars. We do not recorded the time for this first lifeguard to visually locate the simulated victim using binoculars. Two or three other lifeguards were on a watchtower near the beach. Once the victim was located and the alarm had been rung, the lifeguard nearest the shore went into the sea (using swim fins) with a life buoy while another used a jet ski on the beach to head towards the victim. The time taken from starting at the beach (both for the lifeguard and the jet-ski) to reaching the simulated victim was recorded using a waterproof GPS tracker. It appears important to report separately the results for the swimmer and the jet-ski since the availability of a jet-ski is not systematic for the French coast and to provide respective contribution of the swimmer, the UAV and the jet-ski.

UAV patrol (intervention)

A lifeguard with special training for flying a UAV was positioned on the sand dune and launched the drone to a height of 50m. With live video streaming from the UAV to an iPad, the lifeguard was able to fly the UAV and watch its journey. Once the UAV reached the simulated victim, the live video (real-time 720p HD video, with a range of more than 2 km) meant that the lifeguard could assess the situation and