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Simulation and education

Drones may be used to save lives in out of hospital cardiac arrest due to drowning☆

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ABSTRACT

Background: Drowning leading to out-of-hospital cardiac arrest (OHCA) and death is a major public health concern. Submersion with duration of less than 10 min is associated with favorable neurological outcome and nearby bystanders play a considerable role in rescue and resuscitation. Drones can provide a visual overview of an accident scene, their potential as lifesaving tools in drowning has not been evaluated.
Aim: The aim of this simulation study was to evaluate the efficiency of a drone for providing earlier location of a submerged possible drowning victim in comparison with standard procedure.
Method: This randomized simulation study used a submerged manikin placed in a shallow (<2 m) 100 × 100-m area at Tylösand beach, Sweden. A search party of 14 surf-lifeguards (control) was compared to a drone transmitting video to a tablet (intervention). Time from start to contact with the manikin was the primary endpoint.
Results: Twenty searches were performed in total, 10 for each group. The median time from start to contact with the manikin was 4:34 min (IQR 2:56–7:48) for the search party (control) and 0:47 min (IQR 0:38–0:58) for the drone-system (intervention) respectively ($p < 0.001$). The median time saved by using the drone was 3:38 min (IQR 2:02–6:38).
Conclusion: A drone transmitting live video to a tablet is feasible, time saving in comparison to traditional search parties and may be used for providing earlier location of submerged victims at a beach. Drone search can possibly contribute to earlier onset of CPR in drowning victims.

Introduction

The World Health Organisation (WHO) estimates that 372,000 people more than 90% of whom reside in low and middle income countries (LMIC), lose their lives in accidental drownings worldwide each year.[1] Out of n = 137 drowning accidents in Sweden in 2014, a total of 36% occurred in swimming areas and beaches.[2]

Although rare case reports show that neurologically intact survival is possible after prolonged submersion in extremely cold water for 60–80 min[3,4] the European Resuscitation Council[5] states that submersion duration of less than 10 min is normally required for a favorable outcome. The Swedish Registry for Cardiopulmonary Resuscitation (SRCR) shows a median delay of five minutes from collapse to call for help and 15 min from collapse to arrival of emergency medical services (EMS) in out-of-hospital cardiac arrest (OHCA) due to drowning.[6]

Since standard EMS response time usually extends beyond 10 min nearby bystanders and professional lifeguards play a considerable role in the rescue as well as in early resuscitation.[5,6]

In-water resuscitation (IWR) with ventilations can be performed at an early stage by highly trained rescuers with a buoyant rescue aid which increases chances of survival from out-of-hospital cardiac arrest (OHCA) due to drowning.[5,7,8] When the victim is retrieved from the water, cardiopulmonary resuscitation (CPR) should be initiated and an automated external defibrillator (AED) should be attached promptly, although a shockable rhythm is rare in asphyctic OHCA.[5]

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Fig. 1. Perspective from search party with surf-lifeguards walking vertical to shore with the use of a 23 m rescue-line.

Fig. 2. UAV remote controller with tablet display iPad air 9,7″.

According to data from the Royal Lifesaving Society in the United Kingdom (UK) from 2002, a majority (79%) of drowning victims in beach conditions are rescued within 50 m of the shore.[9] Data from Australia show a rate of 128 rescues/100,000 swimmers with offshore wind and rip currents imposing a serious physical hazard to swimmers.[10,11] Rescuing a drowning victim with swimming as the main rescue method is common in cold, deep water.[12] Death of rescuers have been reported due to lack of swimming ability and appropriate flotation devices.[13,14]

As part of the search and rescue (SAR) operation, a trained rescuer response preferably using surf-lifeguards (SL) walking the shallow waters in straight lines has traditionally been used to find submerged drowning victims at lifeguard-patrolled Swedish beaches. However forming such a search party is time-consuming often exceeding 10 min before initiation of the search (Peter Karlborg lifeguard captain Tylösand SLSC, personal communication August 8, 2016) visibility is poor and the inclusion of volunteers impose a risk of fatigue, hypothermia and drowning.

The chance of survival decreases for every minute[15] and Strömsöe et al. speculate that improvements in logistics could increase survival, if initiation of CPR after collapse occurred earlier – within 0–2 min, as compared to start of CPR in >2 min – many lives could theoretically be saved.[16]

In addition, accessibility of rescue diving units is limited in Sweden[17] and both helicopter emergency services (HEMS)[18] and search and rescue (SAR) helicopter services takes time to be recruited.[19]

Unmanned aerial vehicles (UAV), commonly called drones, have increasingly been used for photography as well as for video surveillance, situational awareness and transport purposes.[20,21] Drones have the capability of instant launch, providing live aerial video-stream to a tablet display. Drones have also reportedly been used to aid swimmers in distress by delivering life-buoys.[22]

A drone transmitting live video to a tablet can possibly provide a safe and high-quality visual overview of an accident scene for providing earlier location of a submerged possible drowning victim. To our knowledge there is no other study showing the effectiveness of using a drone for this purpose in a recreational beach environment.

Aim

The aim of this simulation study was to evaluate the efficiency of a drone for providing earlier location of a submerged possible drowning victim in comparison with standard procedure.

Methods

This is a prospective simulation study comparing two methods for the location of a submerged drowning victim in calm conditions at Tylösand beach in the south of Sweden. Live video-stream from a drone to a tablet was compared to traditional rescuer response by a SL search party. Totally n = 10 simulated drownings were presented for each group using a manikin (Laerdal Resusci Junior www.laerdal.com), 112 cm height. The manikin was submerged in the sea between a depth of 0.5–1.5 m within a 100 square m (m^2) predefined search area in randomized and GPS-logged (n = 10) locations for each group.

All locations were GPS-logged, identical and blinded to all participants in both control and intervention group before each search. Time from start at the beach (search party positioned at the shoreline in the same location for all n = 10 tests and the UAV-pilot ready with engines shut-off) to contact with the manikin was set as the primary outcome variable. Both groups were briefed in the same way that a child was missing (submerged) within a 100 × 100 m test area.

All tests were performed in daytime hours during 2 weeks in July and August 2016. The sea conditions were calm with <4 m/s wind, no more than 0.5 m wave height at any point, sandy flat bottom conditions which ranged from 20 cm depth at the beach to 2 m at a maximum distance of 100 m out from the beach.

Search party (control)

A trained rescuer response consisting of (n = 14) SL from Tylösand Surf Lifesaving Club (SLSC) were recruited to form a search party (control), searching for a submerged manikin, Fig. 1. The search party starting at the beach held a rescue-line (23 m) and then walked outwards vertically from shore, looking and feeling for a submerged victim with their feet. The group proceeded until they had water up to their armpits, at about 1.5 m depth, they then turned and proceeded back to shore. The search party made contact with the manikin and initiated in-water ventilations.

Time from start at the beach to contact of the manikin was documented as well as coverage (m^2/min) using a waterproof GPS tracker that recorded time, position and distance. This was placed on the shoulder of one SL at one end of the search party (Finis inc. Hydrotracker, http://www.finisinc.com).

The surf-lifeguards who comprised the search party wore wetsuits, and a maximum time of 30 min to recognition of the manikin was pre-defined in order to protect volunteers from any potential