

Use of Drone Technology for Delivery of Medical Supplies During Prolonged Field Care

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ABSTRACT

Background: Care of trauma casualties in an austere environment presents many challenges, particularly when evacuation is not immediately available. Man-packable medical supplies may be consumed by a single casualty, and resupply may not be possible before evacuation, particularly during prolonged field care scenarios. We hypothesized that unmanned aerial drones could successfully deliver life-sustaining medical supplies to a remote, denied environment where vehicle or foot traffic is impossible or impractical. **Methods:** Using an unmanned, rotary-wing drone, we simulated delivery of a customizable, 4.5kg load of medical equipment, including tourniquets, dressings, analgesics, and blood products. A simulated casualty was positioned in a remote area. The flight was preprogrammed on the basis of grid coordinates and flew on autopilot beyond visual range; data (altitude, flight time, route) were recorded live by high-altitude Shadow drone. Delivery time was compared to the known US military standards for traversing uneven topography by foot or wheeled vehicle. **Results:** Four flights were performed. Data are given as mean (\pm standard deviation). Time from launch to delivery was 20.77 ± 0.05 minutes (cruise speed, 34.03 ± 0.15 km/h; mean range, 12.27 ± 0.07 km). Medical supplies were delivered successfully within 1m of the target. The drone successfully returned to the starting point every flight. Resupply by foot would take 5.1 hours with an average speed of 2.4km/h and 61.35 minutes, with an average speed of 12 km/h for a wheeled vehicle, if a rudimentary road existed. **Conclusion:** Use of unmanned drones is feasible for delivery of life-saving medical supplies in austere environments. Drones repeatedly and accurately delivered medical supplies faster than other methods without additional risk to personnel or manned airframe. This technology may have benefit for austere care of military and civilian casualties.

KEYWORDS: *drone; prolonged field care; medical supplies; delivery; austere environment*

Introduction

War is inexorably linked to illness and injury. Mobilization of medical resources is required to preserve life, limb, and health. Given the mobility and modularity of modern military medical systems, the ability to provide increasingly sophisticated care in the prehospital environment has become not only a reality and necessity but an expectation. Austerity amplifies the complexity of providing care, often because of the scarcity

of resources, security threats to the force, and variable evacuation times. As the Global War on Terror continues to evolve, warfighters may find themselves in prolonged field care (PFC) scenarios as military infrastructure continues to draw down in areas of conflict.¹ Medical supplies can be rapidly consumed by a single casualty and resupply may be limited or entirely unavailable due to risk to airframe or personnel loss required to execute the resupply. Indeed, the same risks that make evacuation impossible on a target may be the same risks that prevent manned airframe resupply.

A drone, also known as unmanned aerial vehicle (UAV), is conventionally defined as an aircraft without a human pilot aboard. Drones originally were developed for military purposes and their use now is rapidly expanding into the non-military and noncombat environments. Healthcare can be expected to be the next logical sector to embrace this technology, given its great flexibility. UAVs have just recently been investigated for transportation of laboratory specimens between remote medical institutions and, more recently, UAVs have been studied for delivery of automated external defibrillators in out-of-hospital cardiac arrest.^{2,3}

In this proof-of-concept study, we explored the feasibility of using a UAV as a system to deliver medical supplies in a simulated, nonpermissive, austere environment during a PFC scenario. We hypothesized that a UAV could successfully deliver life-sustaining medical supplies to a remote, denied environment where vehicle or foot traffic is impossible or impractical.

Methods

Using an unmanned, rotary-wing drone (Vapor 55; Pulse Aerospace, Inc, <http://www.pulseaero.com/>; Figure 1), we simulated delivery of a customizable, 4.5kg) load of medical equipment, including tourniquets, dressings, analgesics, and blood products. The UAV is a 25kg airframe that allows an 4.5kg payload with full endurance, has a maximum cruise endurance with full payload of 60 minutes, and a maximum hover endurance with full payload of 45 minutes. After we received institutional review board and Federal Aviation Administration approval, a simulated casualty was positioned in a remote area located at US Army Camp Shelby Joint Forces Training Center in Mississippi. The flight was preprogrammed on the basis of grid coordinates provided by the tactical medical provider positioned with the simulated casualty moments before

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FIGURE 1 Vapor 55 (Pulse Aerospace) unmanned aerial vehicle.



initiation of flight. The drone flew on autopilot beyond visual range during daylight, owing to military restrictions on night flights. Once at the target location, the UAV hovered 0.6m above ground level and dropped the medical payload to the ground. Altitude, flight time, and route were recorded live and the mission also was recorded and monitored by an overflying high-altitude Shadow drone.

Delivery time was compared with the known US military standards for traversing uneven topography by foot or wheeled vehicle.⁴ Data are reported as mean \pm standard deviation.

Results

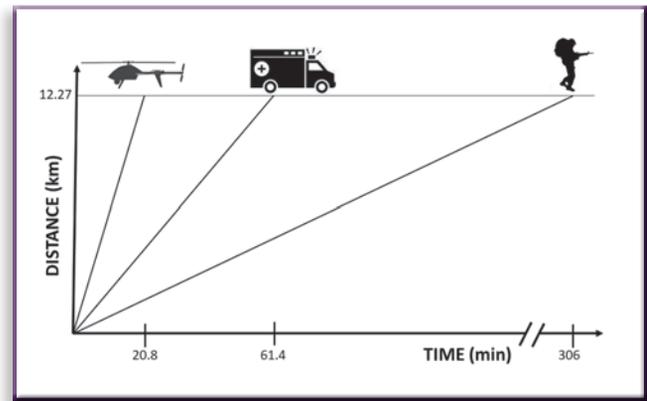
Four flights were performed. Mean time from launch to delivery was 20.77 ± 0.05 minutes (cruise speed, 34.03 ± 0.15 km/h; mean range, 12.27 ± 0.07 km). Medical supplies were delivered successfully within 1m from the target in each flight. The drone successfully returned to the starting point every flight. Resupply by foot would take 5.1 hours with an average speed of 2.4km/h and 61.35 minutes, with an average speed of 12km/h for a wheeled vehicle, if a rudimentary road existed (Figure 2). The time calculated to travel by land does not take into consideration obstacles, unfavorable terrain features, or enemy contact.

Discussion

Expedited evacuation to a medical facility with surgical capabilities has been historically considered the gold standard of management of patients with surgically treatable injuries.⁵ Conventional ground forces do not carry blood products as part of their standard equipment; thus, initiation of appropriate resuscitation may be delayed. Even a single casualty may rapidly overwhelm resources in an austere environment. UAVs can offer a flexible, accurate, and likely affordable solution to some of the challenges of delivering care in austere environments.⁶ Their flight autonomy without the need for onboard pilots and crewmembers eliminates the hazard of personnel loss. More importantly, UAVs offer an unprecedented advantage in flexibility. Drones are normally smaller than conventional, manned helicopters, far less expensive, and require significantly less manpower even when accounting for maintenance and system supervision. As shown in this exploratory work, UAVs can be used with ease to deliver blood products, hemorrhage control supplies, and additional medical consumables to the injured at the point of injury in an austere environment.

Although we did not test this in our work, a larger drone also could be constructed to allow immediate autonomous transportation of an injured soldier to a forward surgical capability

FIGURE 2 Comparison of delivery times by unmanned aerial vehicle, vehicle, and foot march.



after resuscitation is commenced on the ground by the tactical provider.

This technology could be used easily on domestic soil to deliver blood products to rural areas to the injured where transport is expected to be prolonged, hospitals with limited supply of blood products, and during terrorist attacks or natural disasters in areas where supplies are extremely limited or where environments are nonpermissive.

Conclusion

UAV technology has been rapidly expanding over the past two decades with permeation into many industries. In this proof-of-concept study, we demonstrated the feasibility of using UAVs for delivery of medical supplies to trauma patients in austere environments during simulated PFC. UAVs repeatedly and accurately delivered medical supplies faster than other methods without additional risk to personnel or manned airframe. This technology may have benefit for austere care of military and civilian casualties.

Disclosures

The authors have indicated they have no financial relationships relevant to this article to disclose.

Author Contributions

All authors approved the final version of the manuscript.

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