Review Article

# Unmanned aerial vehicle (drones) in public health: A SWOT analysis

**Karthik Balajee Laksham**[1]

[1]*Department of Community Medicine, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Karaikal, Puducherry, India*

## Abstract

In developing countries, lack of access to roads is critical for medical supplies like vaccines and drugs. Air transport like a helicopter is expensive and not affordable. The success of drones in the fields of ecology and environment makes us believe that they can also be used in the field of Public Health as medical couriers. The important strength of using drones is its potential to decrease the travel time for diagnosis and treatment. They are a cost-effective alternative to road transport in difficult terrains. Drones can be used in the transport of blood from the blood bank to the place of surgery and that of specimens from hard-to-reach areas to the labs in nearby towns. They can deliver essential medicines like anti-venom for snake bite and dog bite and prevent deaths. Drones can be employed in disaster relief operations for rescuing victims and in the delivery of food, water, and medicines. Organs can be transported in a short time bypassing the busy traffic. However, operating drones require trained staff and the lack of infrastructure like runway is a potential problem. Drones cannot carry heavier payloads or deliver goods long distances. Drones in the hands of terrorist groups may be weaponized and used for terror attacks. Medical drones may be mistaken for military Drone and attacked by armed forces.

**Keywords:** Unmanned Aerial Vehicle, drones, Public Health, SWOT analysis

## Introduction

Unmanned Aerial Vehicle, commonly known as Drone, is a small aircraft which fly by remote-controlled operation. When we speak about drones, we think about a battlefield, destruction, and death. This is because of the fact that the drones have been conventionally used by the armed forces to drop bombs and destroy enemy targets. These are called the military drones. Apart from this destructive purpose, there are other potential uses of drones as well. They are increasingly being used for civilian and commercial purposes for the delivery of smaller items to locations with difficult access. They provide fast access to images as well as real-time videos. Drones equipped with video cameras are piloted remotely using a smartphone or a computer in environmental studies for aerial air sampling[1] and monitoring greenhouse gases,[2] occupational hygiene,[3] construction industry for safety management,[4] pedestrian behavior study and pedestrian-vehicle crash analysis,[5] wildlife monitoring,[6] and in landscape ecology as in the study of malaria associated with rubber plantations.[7]

## Medical Drones

In developing nations and in areas with mountains, deserts, or forests, roads are impassable and take long-distance travel. Lack of access to roads is critical for medical supplies such as vaccines and drugs. Air transport like a helicopter is the only alternative so far, but it is expensive and not affordable to the patients or the health system. The success of drones in the fields of ecology and environment makes us believe that they can also be used

**Address for correspondence:** Dr. Karthik Balajee Laksham, Department of Community Medicine, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Karaikal, Puducherry - 609 602, India.
E-mail: dr.balajeelaksham@gmail.com

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in the field of Public Health as medical couriers. A study from the Johns Hopkins University School of Medicine has shown that the transportation of laboratory specimens via drones does not affect the accuracy of routine biochemistry, hematology, and coagulation test results.[8] In the United States, the first government-approved delivery of medical supplies by drones occurred in July 2015.[9] This gives us the confidence in employing drones in the transport of medical supplies to remote, difficult to access areas. Dr. Margaret Chan, the former Director-General of the World Health Organization, has said "The use of drones to deliver lifesaving medical products can overcome the lack of infrastructure. We need to let our imaginations soar when looking for ways to get quality medical products to those in greatest need."[10]

## SWOT Analysis

In this review paper, I have assessed the application of drones in Public Health using the SWOT analysis technique. SWOT is an acronym for Strengths, Weaknesses, Opportunities, and Threats. This analysis will be useful to assess the likelihood of a drone's success or failure in public health. Articles on drones were searched in PUBMED and Google scholar. Cross-references from these articles were also obtained. Articles on drone usage in military or warfare were excluded. The strengths and weaknesses inherent to drones and its usage in public health are identified. The opportunities and threats which may likely arise from the external environment are also assessed so that they can be utilized and avoided, respectively. The analysis is presented under the aforementioned four headings.

## Strengths

The important advantage of using drones is its potential to decrease the travel time for diagnosis and treatment. Patients within a 4.6 square mile radius can be reached by a drone in a minute which is 10 times faster than conventional emergency services.[11] Drones are a cost-effective alternative to road transport in difficult terrains. A simulation model has shown that the drones could increase vaccine availability and decrease the costs.[12] As drones fly close to the surface of the Earth, the limitations associated with satellite images, such as cloud contamination, are overcome by drones and they can provide accurate data.[13] Drones can be operated in difficult areas, such as mountains, canyons, or snow-covered ground, and assisted rescue teams in searching and documenting missions.[14,15]

## Weaknesses

There are some limitations of deploying drones in public health. They are as follows:

1. *Manpower and Infrastructure*
   Operating drones require trained staff and continuous monitoring from the ground. Lack of infrastructure like runway is a potential problem; however, it can be overcome by using drones having vertical takeoff and landing. When drones are used for medical purpose, there is a possibility of job loss for those who are currently involved in the transport of medical products. But new staff will be recruited to operate the drones.
2. *Technical Limitations*
   Unlike commercial planes and helicopters, drones cannot carry heavier payloads or deliver goods long distances. The payload of a drone varies between 2 and 4 kg.[11] The smarter a drone, the weight, and its cost would increase. The safety and efficiency of drones are not well established. Biological samples are fragile and need a proper package to prevent tampering in transit. In order to transport drugs/vaccines, ice packs or coolers have to be inbuilt in drones to maintain cold chain. The battery life of drones is a concern, which can be addressed by using solar-powered drones like the Aquila by Facebook.[16] Drones can be programmed to a return-to-safe location if the battery is low or communication is lost. The tolerance of drones to adverse environmental conditions like wind and turbulence is not clear. Electromagnetic interference has disturbed the signal reception in the monitoring of drones from the ground.[17]
3. *Regulations and Legality*
   A major hurdle in the use of medical drones is the legal permission from Aviation authorities. The use of drones for commercial purpose is not permitted in India. In the United States, under the Federal Aviation Administration (FAA) rules, license to fly UAV is granted, provided, the drone must weigh less than 25 kg and must remain within the visual line-of-sight (VLOS) with maximum ground speed of 100 miles per hour and a maximum altitude of 400 ft above ground level.[18]

## Opportunities

The potential use of drones in the field of public health is enormous and it is expanding. Some of them are listed below:

a. *Transport of Blood, Medicines, and Biologicals:*
   1. In developing countries, such as India, there is a shortage of safe blood in hard-to-reach areas.[19] Drones can be used to transport the blood, required for transfusion during surgery or delivery, from blood banks in cities or towns to a remote health center. This will avoid the need to set up blood storage facilities in rural health centers and save costs. They can also be used to deliver blood to mass casualty scenes.[20] The Rwanda Government is involved in delivering blood using drones to clinics located in hard-to-reach areas in a short time and at the cost of motorbike delivery.[21]
   2. In rural areas, the delay in diagnosing diseases due to lack of laboratory facilities can be overcome by the use of drones. Health workers can be trained to collect samples from patients and send them to the nearest laboratory by drones. The results can be sent back to the health worker along with medicines if tested positive. In Madagascar, drones have been used successfully to transport blood samples from villages without diagnostic facilities to laboratories in cities.[22] In Malawi, dried blood sample

from infants, to test for HIV, have been transported using drones.[23] Sputum samples to detect tuberculosis have been transported from a remote village to Kerema city in Papua New Guinea.[24]

3. Drones can deliver essential medicines like anti-venom for snake bite and dog bite, which will prevent deaths from these causes in rural areas.[25] Drones can be used to transport samples and medicines in hospitals from one floor to another or from one building to another. Inside homes drones can help elderly persons in bringing medicines and water. Millions of women in developing countries have an unmet need for contraception. Contraceptives can be transported through drones to rural areas of difficult access, where health staff can collect them and distribute to the beneficiaries. In Ghana, the United Nations Fund for Population Activities (UNFPA) together with the Government of the Netherlands has successfully delivered condoms to rural areas that are difficult to access by road.[26]

b. *Medical Emergencies and Disaster Relief*

In disaster relief operations, drones can be employed in rescuing victims from collapsed buildings or in searching fishermen lost in the sea. They can be employed in the delivery of food, water, and medicines in case of disaster relief and to those injured patients in offshore ships. A drone can serve as an ambulance during emergencies.[27] They can transport devices, such as Automated External Defibrillator (AED), to the site of an out-of-hospital cardiac arrest in a short time and increase the survival.[28,29] AED-equipped drones can give visual feedback and assist a bystander to provide Cardio Pulmonary Resuscitation (CPR) to out-of-hospital cardiac arrest patients.[30] Drones transmitting video is time saving and efficient in locating drowning victims and in delivering a flotation device in comparison to surf-lifeguards.[31,32]

c. *Organ Transplantation*

One of the biggest challenges in organ transplantation is in moving the donated organ from the facility where it is harvested to a recipient admitted at another distant hospital in the shortest possible time. To avoid the delay in this transport, traffic police departments usually create a Green Corridor by blocking the traffic and making way for the ambulances carrying the organs.[33] With the use of drones, organs can be transported in a short time bypassing the busy traffic.[34] Kidneys transported in drones did not show damage related to extrinsic forces.[35]

d. *Surveillance in Difficult Areas*

Surveys that are inaccessible by ground can be done rapidly using drones. In March 2011, following the Earthquake and Tsunami in Fukushima (Japan) radioactive material was released into the environment. Drones with a gamma-spectrometer were deployed to characterize the nuclear contamination and to produce resolution maps of contamination.[36]

## Threats

1. *Safety of the Public*

In a case of an accident, the drone may fall in a residential area and injure the public. Military drones have crashed and caused huge damage.[37] An accidental collision of a commercial drone had caused depressed skull fracture in a 13-year-old boy.[38] In a recreational drone misadventure, a 9-year-old boy suffered a traumatic ocular injury with full thickness corneal laceration.[39] Apprehension among the public exists due to fear of military drones. Attacks by military drones have increased mental health disorders like anxiety in Pakistan.[40] Civilian drones in the hands of extremists or terrorist groups may be weaponized and used for terror attacks. As a security measure, transducers can be attached to track a drone.

2. *Safety of the Drone*

Medical drones may be mistaken for military Drone and attacked by armed forces. There is also a possibility of losing the package carried by the drones. Hackers can hijack a Drone using GPS jammers and loot the Drone or its payload. Softwares resistant to hacking have to be developed.

3. *Air Traffic Congestion*

Drones may interfere with air traffic and cause confusion to commercial planes. In the United States, drones have delayed aerial firefighter planes deployed to fight fire in California.[41]

## Future of Medical Drones

From the above analysis, it is evident that drones have great opportunities in the field of public health. They can be used to transport blood, specimens, and biologicals, such as vaccines to remote places, and reduce the travel time. They can be employed in disaster relief and save lives. Though there are weaknesses and threats in the application of Drones, they can be overcome with the advancement in technology and research. Drone delivery systems and drone delivery ports could be constructed near health care systems. Assessment of public safety and privacy has to be done before scaling up of drones in public health. More studies are needed on the safety of drones, including drone crashes and the reason for crashes. There is also a need for health education to alleviate the apprehension about drones in people's mind.

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## Conflicts of interest

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## References

1. Chang CC, Wang JL, Chang CY, Liang MC, Lin MR. Development of a multicopter-carried whole air sampling apparatus and its applications in environmental studies. Chemosphere 2016;144:484-92.
2. Malaver A, Motta N, Corke P, Gonzalez F. Development and integration of a solar powered unmanned aerial vehicle and a wireless sensor network to monitor greenhouse gases. Sensors (Basel) 2015;15:4072-96.
3. Eninger RM, Johnson RL. Unmanned Aerial Systems in Occupational Hygiene-Learning from Allied Disciplines. Ann Occup Hyg 2015;59:949-58.

4. Irizarry J, Gheisari M, Walker BN. Usability assessment of drone technology as safety inspection tools. Electron J Inf Technol Constr 2012;17:194-212.
5. Ma Y, Wu X, Yu G, Xu Y, Wang Y. Pedestrian detection and tracking from low-resolution unmanned aerial vehicle thermal imagery. Sensors 2016;16:446.
6. Gonzalez LF, Montes GA, Puig E, Johnson S, Mengersen K, Gaston KJ. Unmanned aerial vehicles (UAVs) and artificial intelligence revolutionizing wildlife monitoring and conservation. Sensors (Basel) 2016;16:97.
7. Kaewwaen W, Bhumiratana A. Landscape ecology and epidemiology of malaria associated with rubber plantations in Thailand: Integrated approaches to malaria ecotoping. Interdiscip Perspect Infect Dis 2015;2015. doi: 10.1155/2015/909106.
8. Amukele TK, Sokoll LJ, Pepper D, Howard DP, Street J. Can Unmanned Aerial Systems (Drones) Be Used for the Routine Transport of Chemistry, Hematology, and Coagulation Laboratory Specimens? PLoS One 2015;10:e0134020.
9. Howell C, Jones F, Thorson T, Grube R, Joyce L, Coggin J, *et al*. The first government sanctioned delivery of medical supplies by remotely controlled unmanned aerial system (UAS). In: Xponential 2016, editor. New Orleans, LA; United States: NASA Technical Reports Server; 2016.
10. World Health Organization. WHO | WHO Director-General addresses UK medicines regulatory authority [Internet]. WHO. World Health Organization; 2016. Available from: https://www.who.int/dg/speeches/detail/who-director-general-addresses-uk-medicines-regulatory-authority. [Last cited on 2018 Dec 28].
11. Scott JE, Scott CH. Drone Delivery Models for Healthcare. In: 50th Hawaii International Conference on System Sciences. Honolulu: University of Hawaii; 2017. p. 8.
12. Haidari LA, Brown ST, Ferguson M, Bancroft E, Spiker M, Wilcox A, *et al*. The economic and operational value of using drones to transport vaccines. Vaccine 2016;34:4062-7.
13. Fornace KM, Drakeley CJ, William T, Espino F, Cox J. Mapping infectious disease landscapes: Unmanned aerial vehicles and epidemiology. Trends Parasitol 2014;30:514-9.
14. Van Tilburg C. First report of using portable unmanned aircraft systems (Drones) for search and rescue. Wilderness Environ Med 2017;28:116-8.
15. Karaca Y, Cicek M, Tatli O, Sahin A, Pasli S, Beser MF, *et al*. The potential use of unmanned aircraft systems (drones) in mountain search and rescue operations. Am J Emerg Med 2018;36:583-8.
16. Mark Z. The technology behind Aquila [Internet]. Facebook. 2016 [cited 2018 Dec 28]. Available from: https://www.facebook.com/notes/mark-zuckerberg/the-technology-behind-aquila/10153916136506634/.
17. Abrahamsen HB. A remotely piloted aircraft system in major incident management: Concept and pilot, feasibility study. BMC Emerg Med 2015;15:12.
18. Federal Aviation Administration. FAA News. Summary of Small Unmanned Aircraft Rule (Part 107). Washington, DC 20591; 2016.
19. Ministry of Health and Family Welfare.Government of India. Ministry of Health signs MoU with Government of West Bengal to set up Centre of Excellence in Transfusion Medicine [Internet]. Press Information Bureau 10-July. Press Information Bureau; 2017. Available from: http://pib.nic.in/newsite/PrintRelease.aspx?relid=167284. [Last cited on 2018 Dec 28].
20. Wen T, Zhang Z, Wong KKL. Multi-Objective Algorithm for Blood Supply via Unmanned Aerial Vehicles to the Wounded in an Emergency Situation. PLoS One 2016;11:e0155176.
21. Werber C. Rwanda Is Using Drones To Deliver Blood Donations To Remote Health Centers | The Huffington Post [Internet]. The Huffington Post; 2016. Available from: https://www.huffingtonpost.com/entry/drone-delivery-service-launched-in-rwanda_us_5800f353e4b0162c043b7739. [Last cited on 2018 Dec 28].
22. Perry S. Drones launch off-grid healthcare in rural Madagascar - News from Al Jazeera [Internet]. Al Jazeera Media Network; 2016. Available from: https://www.aljazeera.com/news/2016/10/drones-launch-grid-healthcare-rural-madagascar-161027125640950.html. [Last cited on 2018 Dec 28].
23. UNICEF. Malawi tests first unmanned aerial vehicle flights for HIV early infant diagnosis [Internet]. UNICEF Press Centre. LILONGWE, Malawi; 2016 [cited 2018 Dec 28]. Available from: https://www.unicef.org/media/media_90462.html.
24. Médecins Sans Frontières. How to reach patients in a 'land without Land Cruisers' [Internet]. Papua New Guinea; 2015. Available from: https://www.msf.org/papua-new-guinea-how-reach-patients-land-without-land-cruisers. [Last cited on 2018 Dec 28].
25. World Health Organization. Neglected tropical diseases. Human rabies: better coordination and emerging technology to improve access to vaccines [Internet]. WHO. World Health Organization; 2016. Available from: https://www.who.int/neglected_diseases/news/human_rabies_better_coordination_and_emerging_technology/en/. [Last cited on 2018 Dec 28].
26. Bassett L. Contraception Drones Are The Future Of Women's Health In Rural Africa [Internet]. Huffington Post. 2016 [cited 2018 Dec 28]. Available from: http://www.huffingtonpost.in/entry/birth-control-drones-africa_us_56a8a3b4e4b0947efb65fc11.
27. Church M. We need drones, robots, and autonomous ambulances. BMJ 2015;350:h987.
28. Claesson A, Fredman D, Svensson L, Ringh M, Hollenberg J, Nordberg P, *et al*. Unmanned aerial vehicles (drones) in out- of-hospital-cardiac-arrest. Scand J Trauma Resusc Emerg Med 2016;24:1-9.
29. Pulver A, Wei R. Optimizing the spatial location of medical drones. Appl Geogr 2018;90:9-16.
30. Van de Voorde P, Gautama S, Momont A, Ionescu CM, De Paepe P, Fraeyman N. The drone ambulance [A-UAS]: Golden bullet or just a blank? Resuscitation 2017;116:46-8.
31. Claesson A, Svensson L, Nordberg P, Ringh M, Rosenqvist M, Djarv T, *et al*. Drones may be used to save lives in out of hospital cardiac arrest due to drowning. Resuscitation 2017;114:152-6.
32. Seguin C, Blaquière G, Loundou A, Michelet P, Markarian T. Unmanned aerial vehicles (drones) to prevent drowning. Resuscitation 2018;127:63-7.
33. Annadurai K, Mani G, Danasekaran R. Road map to organ donation in Tamil Nadu: An excellent model for India. Int J Prev Med 2015;6:21.
34. Wapner J. Medical Transport Drones Could Transform Health Care in Overcrowded Cities [Internet]. Newsweek; 2016. Available from: https://www.newsweek.com/2016/02/05/india-organ-transplant-drones-419013.html. [Last cited on 2018 Dec 28].
35. Scalea JR, Restaino S, Scassero M, Bartlett ST, Wereley N.

The final frontier? Exploring organ transportation by drone. Am J Transplant 2018;10:1-3.

36. Lum MJH, Rosen J, King H, Friedman DCW, Donlin G, Sankaranarayanan G,. Telesurgery via unmanned aerial vehicle (UAV) with a field deployable surgical robot. Stud Health Technol Inform 2007;125:313-5.
37. Emily Chow, Cuadra A, Whitlock C. Hazard Above: Drone Crash Database. Fallen from the skies [Internet]. The Washington Post; 2016. Available from: https://www.washingtonpost.com/graphics/national/drone-crashes/database/. [Last cited on 2018 Dec 28].
38. Chung LK, Cheung Y, Lagman C, Au Yong N, McBride DQ, Yang I. Skull fracture with effacement of the superior sagittal sinus following drone impact: A case report. Childs Nerv Syst 2017;33:1609-11.
39. Moskowitz EE, Siegel-Richman YM, Hertner G, Schroeppel T. Aerial drone misadventure: A novel case of trauma resulting in ocular globe rupture. Am J Ophthalmol Case Rep 2018;10:35-7.
40. Shah S, Van den Bergh R, Van Bellinghen B, Severy N, Sadiq S, Afridi SA, *et al*. Offering mental health services in a conflict affected region of Pakistan: Who comes, and why? In: Stewart R, editor. PLoS One 2014;9:e97939.
41. Kovacik R, Goff K. Drones Delayed North Fire Response: Officials [Internet]. NBC News. 2015. Available from: https://www.nbclosangeles.com/news/local/Drones-Delayed-North-Fire-Response-Officials-316615691.html. [Last cited on 2018 Dec 28].