# HISTORY OF TECHNOLOGY

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## Historicizing medical drones in Africa: a focus on Ghana

*Abstract. While the genesis of the drone technology is not clear, one thing is ideal: it emerged as a military apparatus and gained much attention during major wars, including the two world wars. Aside being used in combats and to deliver humanitarian services, drones have also been used extensively to kill both troops and civilians. Revolutionized in the 19th century, the drone technology was improved to be controlled as an unmanned aerial devices to mainly target troops. A new emerging field that has seen the application of the drone technology is the healthcare sector. Over the years, the health sector has increasingly relied on the device for timely transportation of essential articles across the globe. Since its introduction in health, scholars have attempted to address the impact of drones on healthcare across Africa and the world at large. Among other things, it has been reported by scholars that the device has the ability to overcome the menace of weather constraints, inadequate personnel and inaccessible roads within the healthcare sector. This notwithstanding, data on drones and drone application in Ghana and her healthcare sector in particular appears to be little within the drone literature. Also, few attempts have been made by scholars to*

*highlight the use of drones in African countries. By using a narrative review approach, the current study attempts to address the gap above. Using this approach, a thorough literature search was performed to locate and assess scientific materials that focus on the application of drones in the military field and in the medical systems of Africa and Ghana in particular. With its sole responsibility to deliver items, stakeholders of health across several parts of the world have relied on drones to transport vital articles to health centers. Countries like Senegal, Madagascar, Rwanda and Malawi encouraged Ghana to consider the application of drones in her mainstream healthcare delivery. Findings from the study have revealed that Ghana's adoption of the drone policy has enhanced the timely delivery of products such as test samples, blood and Personal Protective Equipment to various health centres and rural areas in particular. Drones have contributed to the delivery of equity in healthcare delivery in Ghana. We conclude that with the drone policy, the continent has the potential to record additional successes concerning the over-widened gap in healthcare between rural and urban populations.*

*Keywords: drones; medical drones; Africa; Ghana; Unmanned Aerial Vehicles (UAVs); Unmanned Aerial System (UAS)*

**Introduction.**

Drones, or Unmanned Aerial Vehicles (UAVs), are smaller aircrafts controlled by computers and pilots (Coeckelbergh, 2013; Scot and Scot, 2017). They are short-range technology that can fly twenty (20) minutes or more before batteries are replaced or charged (Lin, Karishma, Cherie, & Sachin, 2018). In contemporary times, drones have been applied to various sections of human endeavor. The major application of this technological device is its usage as a delivery mechanism for the transportation of items in timely manner (Scott & Scott, 2017). Also, areas such as photography, security, racing, architecture and consumer goods delivery have witnessed the application of innovative drones (Lin, Karishma, Cherie, & Sachin, 2018).

Recently, advancement in medicine and the application of technology to medicine have given rise to the use of medical drones to carry medical equipment to service the needs of people in emergency situations (Bamburry, 2015). Their ability to bypass road closures and fly over terrains with no risks made them ideal for such purposes (Balasingam, 2017).

Africa, and Ghana in particular, is consistently ranked at the bottom in the area of health and healthcare indicators (Mazibuko, 2019). Over the years, there has been a wide gap between rural and urban dwellers in Africa concerning healthcare delivery (Adindu, 2010). The hope to stem the growing wider disparity between rural and urban areas in the area of health has informed governments to implement relevant policies. Currently, one of such policies has been the introduction of medical drones. At their inception, it was anticipated that they will serve as mediums through which medical deliveries would be expedited to meet the growing needs of the population in

impassable areas. Evidence from earlier sources indicate that they have been used to transport equipment, pharmaceuticals and vaccines to -and fro- the rural areas.

Since its introduction, scholars have attempted to provide data on the impact of drones on healthcare across Africa and the world at large. For example, the studies of Balasingam (2017), Washington (2018), Ackerman & Strickland (2018) and Knoblauch et al. (2019) among many others have made important contributions to the discourse on drones. Indeed, drones have been introduced to support the healthcare systems of some countries in Africa south of the Sahara. These studies have reviewed the nature and state of the application of drones with emphasis on healthcare in Malawi and Rwanda (Balasingam, 2017; Lin, Karishma, Cherie, & Sachin, 2018), Madagascar and Senegal (Knoblauch et al., 2019; Nouvet et al., 2019) and some selected countries in East Africa (Ackerman & Strickland, 2018). The debates of these studies revolve around the strengths, opportunities and weaknesses of the technology in Africa's healthcare.

The above notwithstanding, data on Ghana appears to be limited within the drone literature. Thus, little is known about the extent to which the application and contribution of drones affect the health systems in Ghana. The nature of drone application in Ghana in relation to other African settings are not well understood. The current paper uses a narrative review approach to investigate the application of drones in African medical systems with particular reference to Ghana. Also, we have paid attention to how drones were applied to the fight against the COVID-19 pandemic in Ghana. Drawing on a narrative review approach, we seek to obtain a broader perspective on the theme in Africa. This would help us to establish clarity from the literature for our analysis and inferences based on existing evidence.

**Method.**

The current study uses a narrative review approach. The main rationale underpinning our reliance on the narrative review approach was basically to obtain a broader perspective on medical drones in Ghana and Africa in general. We were interested in establishing clarity in gleaning literature for our analysis and inferences based on existing evidence.

We have used both academic and non-academic literature sources to piece this manuscript. Concerning the academic, we conducted a systematic search in databases related to the development of drones in the world, Africa and Ghana in particular to locate information that were in line with the focus of the discourse. Data collected from government briefs, reports and opinion posts formed the non-academic sources of the discourse. The nonacademic sources were utilized in our hope to capture the latest information concerning drones and its application in Ghana.

Again, the scanty nature of published resources on the theme in Ghana partially influenced our idea of incorporating non-academic sources in the study. Both the academic and non-academic literature sources have been pieced together and grouped

thematically to reflect the object of the study. Significantly, the two different sources have been used to corroborate each other.

**Literature search.**

A thorough literature search was performed to locate and assess scientific materials concerning the application of drones in the medical systems in Africa. Databases such as google scholar, Science Direct, Wiley and Emerald Insight were used as search engines to locate scientific materials. The searches were done to identify materials that contained the following keywords or phrases: "drones", "history of drones", "drones in Africa", "application of drones", UAVs, and "drones in health and medicine". The titles and abstracts were screened for relevance and selection, to ascertain whether they were applicable to the discourse.

The criteria for selecting a material depended on the requirement that the material was published in English and possesses relevant data on any of the themes under review. In the course of selection, all materials that presented biased findings were ignored. All duplicate search results were exempted. Also, we did a thorough review of the references or the bibliography of the selected materials to further review and identify other studies worthy of contact. Concerning this, there was emphasis on materials that discuss the application of drones and medical drones in Africa and Ghana in particular.

**Results.**

Information from Table 1 below enumerates our search results from the various databases. Initially, our search in google scholar presented 11,200 journal articles. Out of this, 200 were finally contacted after a filter. Also, our initial search in the Science Direct database yielded 14,094 results, out of which 203 were contacted after filtering inapplicable materials. Similarly, a search in the Wiley database presented the researchers with 91, 963 sources. Only 94 of these were consulted after filtering. Concerning Emerald Insight, our initial search endowed us with 1002 journal articles; nine (9) were contacted. From the articles consulted, we further filtered after reading titles and abstracts. Through this process, irrelevant materials were forfeited for applicable ones.

**Table 1.** Search results from databases.

| Database | Initial search results | Results after filter |
|---|---|---|
| Google Scholar | 11,200 | 200 |
| Science Direct | 14,094 | 203 |
| Wiley | 91,963 | 54 |
| Emerald Insight | 1002 | 9 |

**Discussions.**
**The drone.**

Scholars are still contesting the conception of the drone across time and space. Existing literature argues that the term drone, was coined because of the similarity between the sound and loudness of old military unmanned target aircraft and that of a male bee (Rosser, Vignesh, Terwilliger, & Parker, 2018). Over the years, several terms have been coined to describe the activities of drones. These include Unmanned Aerial Vehicle, Unmanned Aerial Systems and unmanned aircraft. Concerning unmanned aerial vehicle (UAV), the term was first coined in the 1980s to describe autonomous or remotely controlled and multiuse aerial vehicles that are driven by aerodynamic forces and are capable of carrying a payload (Rosser, Vignesh, Terwilliger, & Parker, 2018). Among other things, scholars adopted UAVs to draw a distinction between same and other aerial systems including ballistic vehicles, gliders, balloons and cruise missiles. It has been argued that a more accepted term is Unmanned Aerial System (UAS) (Rosser, Vignesh, Terwilliger, & Parker, 2018).

The properties of drones differ depending on the kind of drone and its purpose. However, every drone has an air frame, propulsion system and navigation system. Rosser et al (2018) have argued that the most common configurations of drones include fixed-wing, rotary-wing, multi-rotor and hybrid designs. Most of the drones that exist today have remote sensing equipment, cameras, ground-penetrating radar, direct measurement sensors, communication equipment and cargoes (Rosser, Vignesh, Terwilliger, & Parker, 2018).

Drones exist in different sizes, shapes and sophistications. There is the hand-thrown Ravens and the forces' Global Hawk; which can reach altitudes of sixty thousand feet. Irrespective of the size, drones provide intelligence, surveillance and reconnaissance to war managers (Shaw, 2013, 2014). The MQ-1 Predator is the most widely recognized military drone in contemporary times. Its wingspan is 55feet with a length of 27 feet and can reach a speed of 135 miles per hour (mph). Many operators use remote technologies to control. It has been reported that more than 2,900 people have been killed in 442 strikes in Pakistan with drones playing a major role (Shaw, 2014; Rosser, Vignesh, Terwilliger, & Parker, 2018). An average drone flight involve dozens of human operators, analysts, observers and lawyers. In fact, the drone such as the MQ-1 Predator requires between 90 and 200 personnel (Elish, 2017). Today, drones appear much smaller than they were in the past.

**History of drones.**

The debate surrounding the history and emergence of drones in the world is complicated and unresolved. While some scholars associate the first application of drones to the 1800s (Balasingam, 2017; Attuquayefio, 2014), others like McDougal (2013) believes that drones first emerged during the First World War for military purposes. To those who support the former, one of the earliest recorded history in drone application happened in July 1849 when Austrians, after launching pilotless

balloons mounted with bombs, directed same against the city of Venice (Shaw, 2013). During the nationalist revolutions of 1848 in Europe, Austrians were struggling to hold onto their empire and had to deploy drones in their actions. Subsequently, they deployed about 200 war balloons against the Venetian Republic. While balloons had been used widely for reconnaissance missions, especially during the Napoleonic era, Austrian balloons assumed a new dimension: instead of human, they were loaded with 33 pounds of explosives (Packer & Reeves, 2013).

**Table 2.** Evolution and historical development of drones.[1]

| Phase | Development | Time Frame |
|---|---|---|
| **Phase I** | The Target Drone | Early 20th Century |
| **Phase II** | The Flying Bomb Drone | Interwar Period |
| **Phase III** | The Surveillance Drone | Cold War |
| **Phase IV** | The Hunter-Killer Drone | Post-September 11, 2001 |
| **Phase V** | The Police Drone | Post-September 11, 2001 |
| **Phase VI** | Medical Drone | 2015– till date |

In contrast to the Austrian development, McDougal (2013) asserts that drone technology first emerged during World War I when the U. S. Navy hired Elmer Ambrose Sperry to develop a fleet of unmanned air torpedoes that could be directed by catapult to a specific target. However, it has been reported that during the United States Civil war, Confederate and Union forces had flown balloons for reconnaissance missions. Also, aerial surveillance later emerged in the 1898 Spanish-American War when the U.S military fitted a camera to a kite and became very extensive during World War I (Shaw, 2014).

The drone technology was revolutionized in the 19th century. Specifically, in 1896, Samuel Pierpont Langley, an American astronomer, developed a steam-powered aerodromes (Figure 1), unpiloted aircraft that were flown successfully along the Potomac River near Washington (Shaw, 2014). On May 6, 1986, Langley's discovery successfully flew for 3,300 feet (Kindy, 2021). As a result of his success, he obtained a substantial amount of $50,000 from the U.S government to build powered aircraft that can be controlled by pilots (Taylor, 1990). Considering the weight of a full-sized steam engine, Langley called on his assistant, Charles Manly, an engineer to build a gasoline engine (Wood, 1985; Pelsser, 2003). This resulted in a tandem-winged design with a cruciform tail that could be launched from the top of a houseboat using a new mechanism (Pelsser, 2003; Kindy, 2021).

During World War II, a remote controlled unmanned aerial devices were improved to target German troops. Furthermore, during the cold war, the technology of drone led to a new discovery called the rocket technology. Afterwards, many

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[1] From Phase I to Phase V, drones were used as a military devices from the early 20th till date. However, in contemporary times, a new dimension has been added to drones technology, making it possible to be used within the healthcare sphere.

developed nations employed military drones on surveillance and reconnaissance missions (Shaw, 2014).

Militarily, drones have been used in combats and to deliver humanitarian services (Scott & Scott, 2017). Coeckelbergh (2013) reports that drones were used by countries like Afghanistan, Pakistan, Yemen and Somalia to battle both civilians and armed men. The September 11th event of 2001 prompted the CIA and Air Force to use drones for surveillance and missiles mission. This form of drones were called Predator Drones with Hellfire Missiles (McDougal, 2013). The Predator drone, first used in 1995 was only operated remotely in 2001 (Bowden, 2013; Elish, 2017).



**Figure 1.** Langley's Aerodrome (National Air and Space Museum Archives, Smithsonian Institution).



**Figure 2.** Langley's Aerodrome (National Air and Space Museum Archives, Smithsonian Institution).

**Figure 3.** SDI Surveillance drone (invented in England in 1962)[2] (Imperial War Museums).



**Figure 4**. Predator drone [3] (Bowden, 2013).

In 2002, six alleged Al-Qaeda operatives were killed by drone fire (Attuquayefio, 2014). An outstanding advantage of using drone for military purposes has been its proclivity to limit the number of personnel used to inflict more strategic pain on one's enemy (Coeckelbergh, 2013). They have been very useful in the areas of surveillance and for destruction of people and properties on the ground (Coeckelbergh, 2013).

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[2] The SDI Surveillance drone was the first of a family of new drones that was acquired by the Royal Artillery in the 1960s to extend their observations over the battlefield and to locate targets for new long range weapons.
[3] The Predator drone has been used in times of war since the era of WWII. This was revolutionized in 1995.

In post September 11, scholars have termed drones as game changer of development and security across the globe and Africa in particular. Concerning the history of drones in Africa, the drone was first developed in the 1970s for surveillance purposes. According to Sandvik (2015), this innovation serves as a legacy of technological imperialism and colonial airpower. Within the apartheid era, South Africa witnessed the deployment and development of drone in their politics for about forty years. The first known type, the Champion, was developed by the South African Council for Scientific and Industrial Research in 1977 and handed over to the South African Air Force a year later (Sandvik, 2015).

The innovation and application of drones in Africa rose out of a growing concern and perception about Africa as an area in need of external drone intervention (Sandvik, 2015). This has caused major drone industries to identify and promote the use of drones in new areas including health and healthcare.

### The essence of drone technology.

Since its inception, drone bombing became the most ultimate distancing technology in the military (Coeckelbergh, 2013). Since the reign of President Barrack Obama, the United States has relied on the use of drone's intervention in the growing conflicts across Africa and Sub-Saharan Africa in particular (Attuquayefio, 2014). As a pilotless aircrafts, the UAVs, popularly known as drones, give trackers easier and faster access to the often difficult terrain (Goodyer, 2013; Balasingam, 2017).

Aside developed countries, developing countries use drones to intervene in times of disasters, fire and during the outbreak of war (Scott & Scott, 2017). As a technology, the drone has been regarded as a disruptive force in the field of transportation (Scott & Scott, 2017). Following the military unrests that engulf sub-Saharan Africa, and Africa in general, the US and other stakeholders such as the United Nations (UN) have been deploying UAVs to convey military hardware such as missiles and cameras as well as network mediums for reconnaissance, surveillance and target engagement missions (Attuquayefio, 2014). In the *Hawaii International Conference on System Sciences* held in 2017, Scott and Scott argued that drones have also been used to fuel crimes including the delivery of contrabands to inmates. It also delivers firing weapons and encourages terrorism and hacking.

Aside the military, there is a growing body of literature that addresses the application of drones in several arenas of development and human endeavor across Africa and the world. The first non-military drone use occurred in an outbreak of a major disaster. Its ability to provide extreme human need in unfavorable geographical and transport networks made them ideal for such tasks. Among the major disasters that witnessed the application of drones include the 2010 Haiti Earthquake, the 2012 Hurricane in North-East U.S, Canada and the Caribbean, the 2015 Category 5 Cyclone in the Island of Vanuata and the 2015 Nepal Earthquake among others (Balasingam, 2017).

Over the years, the application of drones in various human endeavours have aided developments across the African region and the world at large as it reduces time, cost and improves delivery efficiency (Bamburry, 2015). Scientifically, drones have also been applied to the area of research and exploration for monitoring events such as fire outbreak and riots (Scott & Scott, 2017). They have been tried in data collection from remote areas (Bamburry, 2015). In sports and entertainment, drones have been used for live event coverages. In contemporary times, spraying of crops has been among the known roles played by drones in the world (Scott & Scott, 2017). In addition, drones have been given a centrality in the fight against poachers; they have been adopted to be used as an aerial surveillance mechanism to stem poaching in some parts of East Africa (Goodyer, 2013).

While drone usage has been projected by both Bamburry (2015) and Scott and Scott (2017) to be persistent in all states in the foreseeable future, it appears the future is closer than anticipated. Significantly, one notable application that has gained recognition among stakeholders is the adoption of drones in the area of medicine. Used for emergency services, the application of drones in medicine includes provision of disaster assessments when other means are restricted; delivering aid packages, medicines, blood, and vaccines to remote areas and for transporting disease test samples. In the era of COVID-19, drones proved very effective. It facilitated the delivery of medical supplies to mountainous and geographically challenging locations. It has been contended that, the congestion of cities and extreme weather conditions can be obstacles to emergency medical deliveries (Scott & Scott, 2017). The rest of the sections that follow address the application of drones in the African medical context.

**Drones in African healthcare systems.**

Africa has been noted as a continent with a myriad of systemic failures in several areas of development. In healthcare, the continent has been defined as the region with health system fragility (Adindu, 2010; Mazibuko, 2019). The incidence of health system fragility and the inadequacy of healthcare managerial skills have continually raised questions during the peak of major infections or epidemics in Africa (Adindu, 2010; Mazibuko, 2019). To lessen some of these burdens, several policies, including the use of drones in healthcare, have been adopted and implemented by African elites. Since its inception, medical drones have contributed immensely toward the delivery of healthcare in Africa and elsewhere.

Drones have been used for surveillance of disaster sites, areas with biological and chemical hazards and tracking the spread of diseases. Evidence suggests that in the Western countries, drones are used to gather information about the number of patients in need of care (George, 2017; Rosser, Vignesh, Terwilliger, & Parker, 2018). Serving as a means of improving efficiency, response teams of the National Health Service in England investigated the use of drones in assessing injuries related to chemical, biological and nuclear materials (Rosser, Vignesh, Terwilliger, & Parker, 2018).

**Figure 5.** Drone Transporting Medical Items in Switzerland[4] (Peck, 2019).

Also, the application of drones in medicine has improved the concept and practice of telemedicine. The technological literature provides evidence to suggest that drones have been extensively used for telemedicine. This includes the use of remote diagnosis treatment of patients by means of telecommunication technology (Rosser, Vignesh, Terwilliger, & Parker, 2018; Bhatt, Pourmand, & Sikka, 2018; Wulfovich, Rivas, & Matabuena, 2018). In several instances, the concept of tele-monitoring (the provision of remote guidance by an experienced surgeon to a less experienced colleague) using computers and telecommunication in healthcare has also been enhanced using medical drones (Rosser, Vignesh, Terwilliger, & Parker, 2018).

The successes elsewhere and within African countries such as Senegal, Madagascar, Rwanda and Malawi encouraged a country like Ghana to consider the application of drones in her mainstream health delivery (Washington, 2018). In Rwanda, her drone project commenced in 2016 (Lin, Karishma, Cherie, & Sachin, 2018). The purpose was to transport sachets of blood to peripheral health centers (Knoblauch et al., 2019). In this project, the implementation focused on regions where health facilities are isolated by Island geography (Knoblauch et al., 2019). Like elsewhere, the Rwandan drone technology extended services towards the transportation of lab samples, delivery of medical treatments for emergencies and delivery of medicines and medical supplies (Knoblauch et al., 2019). With evidence from advanced economies, drones have shown the proclivity of being used to ensure the extension of medical services to underserved areas. In the U.S, drones, since their inception, have continually supplied medication and other needed healthcare items to rural areas (Lin, Karishma, Cherie, & Sachin, 2018).

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[4] The Swiss drone was manufactured by a California-based company known as Matternet. According to Peck (2019), the drone flew toward the opposite side of Lake Zurich to transport clinical laboratory samples between hospitals in urban areas.

In Rwanda, a California-based company known as Zipline is the primary inventor of the drone that delivers blood to remote areas in the East African country (Glauser, 2018). Zipline's goal is to be a primary distributor for most rural hospitals (Ackerman & Strickland, 2018). The Zip drones are able to make emergency deliveries at night through heavy rains, high winds, and darkness (Ackerman & Strickland, 2018). Drones have been used to transport blood products and medicines to hospitals with critical and/or severe cases as well as remote areas (Balasingam, 2017). Hospitals order blood and medicines via text messages and interactive platforms such as WhatsApps and receive them within 30minutes (Balasingam, 2017).

Aside the functions discussed above, Malawi's application has taken a different dimension. The literature reports on the application of drones concerning the fight against HIV/AIDs. It has been reported that the UN Children's Fund (UNICEF), continually use drones to deliver HIV test kits to the country. This reduces the time required to test infants within rural areas (Balasingam, 2017). In a similar manner, Google has partnered with UN Children's Fund (UNICEF) to use *Matternet* for the transportation of blood samples in Malawi. The various samples are transported from rural communities in Malawi and other African countries to large hospitals to test HIV/AIDs and other disease (Lin, Karishma, Cherie, & Sachin, 2018). Also, Washington (2018) adds that Malawi's drones are used to identify cholera hotspots in Lilongwe – the capital of Malawi. Again, Washington hints that, aside Malawi, countries like Ghana and Madagascar have been reported to apply drones to deliver vital articles such as HIV and TB test kits, birth control, condoms and medical supplies to and from rural areas (Washington, 2018).

Evidence from country studies indicate that the application of drones in medicine have contributed immensely toward rural health care (See for example studies like; Lin, Karishma, Cherie, & Sachin, 2018; Scott & Scott, 2017; Ackerman & Strickland, 2018; Nouvet et al., 2019). Inadequate communication and inaccessible roads in rural areas have been notable barriers to healthcare delivery across Africa. The introduction of drones have partly served as panacea to the ailing healthcare delivery system in Africa. With the introduction of drones in medicine, inaccessible roads are no longer barriers to the delivery and transportation of drugs, blood and other useful healthcare items (Scott & Scott, 2017). It has been noted by Nouvet et al. (2019) that in rural and remote areas in Madagascar, drones are used to control the surge in tuberculosis cases.

Evidence and the qualities of the technological device suggest that drones have the potency of slashing delivery time from days to minutes (Ackerman & Strickland, 2018). Also, it has been argued that prior to its introduction, blood often expired in shelves and banks across many countries in Africa (Glauser, 2018). While curbing blood expiration, drones help to address emergency situations which sometimes lead to loss of lives.

Aside healthcare, the application of drones in Africa has been successful in population and wildlife monitoring, agriculture, archaeology and prevention of genocide (Washington, 2018). Evidence deduced from the South African and

Namibian Defence Forces indicates that eco-drones that use satellites, cameras and predictive analysis are flown over game reserves to control poaching of endangered rhinos and elephants. Concerning the South African rangers, their technological drone device is specifically geared towards the prevention of wild-life extinction (Washington, 2018). Evidence from Morocco also indicates that UAVs are used to track illegal maritime activities and oil spills (Washington, 2018). Drones in Ethiopia release sterile insects (tsetsefly) into certain regions on a weekly basis (Washington, 2018).

Since the implementation of the drone programme became a success, many health stakeholders around the world considered the idea of incorporating same into mainstream health care. Examples include Senegal, Ghana and Canada among others (Glauser, 2018). It is reported that in Senegal, since 2017, the government is assessing the usefulness, health impact and cost-effectiveness of applying drones within the health supply chain (Knoblauch et al., 2019). While information on the Ghanaian government and drone is scant and still remains at its infant state, we have tried to draw some nuggets from various reports on the viability of drones in the mainstream of Ghana's healthcare delivery in the section that follows.

Over the past decades, as a result of its numerous applications, UAVs have become a growing market. It has been reported that within a year, and at the end of April 2016, the purchase of drones among major stakeholders increased exponentially (Lin, Karishma, Cherie, & Sachin, 2018). In a 2016 study, Lin and his contemporaries argued that future application, adoption and use of drones have the potential of reducing waiting time in hospitals. They are of the view that drugs can be delivered at the doorstep of patients for emergency services within few hours (Lin, Karishma, Cherie, & Sachin, 2018). Concerning delivery, it is argued that there is the launch of more than fifty (50) drones daily on the delivery mission of African countries (Glauser, 2018). The capability of drones to navigate using the Global Positioning System (G.P.S.) can enable doorstep delivery (Balasingam, 2017). In a similar manner, Balasingam (2017) proposes robot-like drones to be aided to deliver medication to elderly people in homes (Balasingam, 2017).

It is not a mistake to conclude that in Africa, there are inadequate health centers (Adindu, 2010). The inadequacy of health centres coupled with unpleasant living condition breed pressure on the existing health facilities. Issues surrounding inadequate medical personnel, lack of essential equipment and bed spaces burden almost all medical facilities in the region causing daily traffic among patients who are seeking healthcare. We argue based on the analysis that considering the use of drones for doorstep delivery of essential medical apparatuses including drugs, would contribute to the decrease of traffic in the fragile western-oriented healthcare systems across Africa.

Specific drones for delivery have their varied and specified amount of time and distance they could cover. A renowned drone referred to as the *Parcelcopter (3.0)* has been reported to have the ability to travel for only 5miles (Lin, Karishma, Cherie, &

Sachin, 2018). This type of drone which is a 'compact flying toolbox can contain life-saving supplies such as automated external defibrillator, medication and/or cardiopulmonary resuscitation aids (Lin, Karishma, Cherie, & Sachin, 2018).

**The Ghanaian case.**

The Ghanaian drone policy was implemented by the government of the New Patriotic Party (NPP) to contribute to addressing Ghana's healthcare fragility. Commencing in April 2019, the vice president of the country launched the world largest medical drone delivery network in the Eastern Region of Ghana (Adu-Gyamfi et al., 2019; Ministry of Health, 2019). Similar to the Rwandan case, the drone service in Ghana was designed and installed –and is currently being controlled- by a US-based Zipline International Inc. in partnership with the Ghana Health Service (Ghana Health Service, 2017).

"Ghana's drone makes on-demand emergency deliveries of 148 different vaccines, blood products and life-saving medications to health facilities in the country, 24 hours a day" (VOA, 2019). Evidence suggests that the New Tafo hospital in the Eastern Region of Ghana was the first health facility to receive the services of the drone. Within this hospital, a 7year old boy was admitted and needed a blood transfusion of O-negative. Within some few minutes the item was delivered by drone (VOA, 2019).

At inception, the government reported that the sole aim for introducing the drones in Ghana's healthcare system was to leverage technology to advance the supply chain of critical medical supplies. Earlier information suggests that the delivery of these critical and vital supplies by the drone has the tendency to reduce time-wasting and save lives (GHS, 2017). The project, entitled *'fly-to-save-a-life'*, has been a 24-hour health delivery system which is expected to make on-demand delivery of medical needs to about 2000 health facilities –including those in rural areas (Ministry of Health, 2019). Importantly, the introduction of medical drone is motivated by government's goal to bridge the over-stretched gap in medicine or healthcare between urban and rural areas. The above was envisaged to enhance the achievement of a Universal Health Care delivery system among Ghanaians (Ministry of Health, 2019). To that extent, government has sought to make healthcare equitably distributed to both rural and urban populace.

Over the years, Ghana has been burdened with maternal mortality. While the partial improvement of healthcare logistics and the introduction of healthcare programmes have eased the burden of maternal mortality, the pace appears to be slow as the country still faces the burden (Apanga & Awoonor-Williams, 2018). Statistics indicate that Ghana's maternal mortality ratio has declined from 760 per 100,000 live births in 1990 to 319 per 100,000 in 2015 (Apanga & Awoonor-Williams, 2018). This has shown a growing pace towards the achievement of the aspects of Millenium Development Goals (MDGs) that focus on maternal health.

**Figure 6.** A Medical Drone Making delivery in Ghana[5] (Rayner, 2019).

To hasten governments aim to yield the expected results of 70 per 100,000 live births by 2030, the government of Ghana thought that it is expedient to apply drones to maternal health. In a presidential address to the nation, the Vice President retorted that the drone project would help reduce maternal mortality. The application of drones include, to transport blood within few minutes or hours to labour wards (Ministry of Health, 2019). Also, the United Nations Population Fund (UNPF) and the Dutch government hoped to address access to women's health clinics in Ghana with drones. Their activities included using drones to deliver contraceptives and other gynaecological supplies to women in rural areas within Ghana (Rosser, Vignesh, Terwilliger, & Parker, 2018). Aside maternal health, the implementation of the drone policy has yielded positive results in addressing complications such as snake bites, accidents and other life threatening emergencies (Ministry of Health, 2019).

**The Medical Drone during the Era of COVID-19.**

As a result of Africa's healthcare fragility (Adindu, 2010), many stakeholders of health became concerned about the impact COVID-19 could wreak on the continent. Concerning Ghana, a country with less than one hundred ventilators, at the inception of the virus, the projection of fatality rate was beyond measure. Any success story achieved by Ghana during the COVID-19 outbreak could be partly attributed to the use of medical drones. Due to the use of medical drones, other essential services to meet

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[5] The Drone above is known as Zips and was invented by a US robotics company, Zipline. Among other things, the device can transport up to 1.5 kg of blood over 150 km (Rayner, 2019). It has been suggested by Rayner that, "the drones will be able to ferry 150 different medicines and vaccines, as well as blood, to more than Ghanaian clinicians, covering 12 million people."

other pressing health needs were not curtailed. The fight against COVID-19 should be explored by countries in future epidemics and pandemics.

As a delivery device, Ghana's medical drones have been used to transport and expedite COVID-19 test swabs to -and fro- research centers (Konert, Smereka & Szarpak, 2019; Baker, 2020). Initially, the country relied on ambulatory services to deliver test samples, test tubes and important articles such as Personal Protective Equipment (PPEs) to health facilities and health workers. The reliance on ambulatory services, although useful, witnessed a myriad of challenges. This included barriers to transportation due to inaccessible roads and time factor. Originally, it could take up to five (5)n days to get results for test samples.

Baker (2020) is of the view that Ghana's application of medical drones was reported as the first time of applying such device drones to the fight against COVID-19. Concerning its application, it was reported that:

*...As the Municipal Director of Health Services for a rural district of Ghana, Sarkodie had ordered an entire camp of 244 construction workers into quarantine when three of them tested positive for the novel coronavirus...on April 17, instead of driving the test swabs two hours to the capital, Accra, for analysis, he had them dropped off at a health facility one district over. Within a few minutes, they were winging their way to a testing facility via autonomous drone... Two days later, the results came back via SMS: negative. The workers could be let out of quarantine (Baker, 2020).*

The reliance on drone for the fight against the pandemic proved very effective and worthy. Significantly, Ghana was able to save hours and days from the time it took to get COVID-19 test from suspected rural victims to the urban areas (Baker, 2020). On average, Zipline's fleet in Ghana was tasked to transport up to 15,000 tests a day in 300 flights (Baker, 2020). The drones also transported vital supplies such as PPEs to health workers across the country. Subsequently, Zipline considered applying same technological advancement in America (Baker, 2020). The use of the drone for delivery mission can equally be applied to several arenas of development as time unfolds.

### Conclusion.

Access to healthcare has been a major challenge to Africa and Ghana in particular. The discourses on the history of medicine and healthcare in general have highlighted the threats and challenges of extending scientific medical services and healthcare in general to rural and remote areas in certain parts of the African continent. Inaccessible roads, time factor and lack of essential materials in rural healthcare centers have generated grave concerns among stakeholders.

Drawing on a compendium of internet and journal articles, we have discussed the application of drones in the mainstream of the medical systems in Africa in general and Ghana in particular. Findings from the current study indicate that drones, otherwise known as, Unmanned Aerial Vehicles (UAVs) have become a growing market over the years. First, it was used by states as a military weapon, the device has been applied

to different sectors of the economy including health. With its sole responsibility to deliver items, stakeholders of health across several parts of the world have relied on the device to transport vital articles among health centers. Concerning Africa, countries like Senegal, Madagascar, Rwanda and Malawi encouraged Ghana to consider the application of drones in her mainstream healthcare delivery system.

Since its inception in Ghana's medical care, important medical/health kits such as test samples, blood and PPEs to be distributed to various health centres with rural areas being the prime concern. The contribution also paid attention to the application of medical drones to the fight against the current Coronavirus burden in Ghana. The country under study has deployed the medical drone to deliver COVID-19 test samples and PPEs to health workers across the country.

We argue that the introduction of medical drones in Africa and Ghana in particular can create the opportunity to bridge the over-widened gap in healthcare between the rural and urban population. The introduction of the drone has demonstrated potential resilience against several barriers. It has demonstrated that it has the ability to be used within several aspects of human endeavours. To this end, future research needs to explore similar areas where the device can be applied; in particular, the concentration should be based on empirical data.

**Conflicts of Interest.**
The authors declare no conflict of interest.

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## Історізація медичних дронів в Африці: в центрі уваги Гана

***Анотація.*** *Хоча походження технології роботи дронів до кінця не вивчено, зрозуміло одне: вони виникли як військовий апарат і привернули велику увагу під час великих воєн, включаючи дві світові війни. Крім використання в бойових діях і для надання гуманітарних послуг, дрони також широко використовувалися для знищення як солдат, так і мирних жителів. Революційно технологія дронів була вдосконалена в XIX столітті, з'явилася можливість ними управляти як безпілотними літальними апаратами, призначеними головним чином для націлювання на війська. Нова сфера застосування безпілотних літальних апаратів – це сектор охорони здоров'я. З роками сектор охорони здоров'я все більше покладається на пристрої для своєчасного транспортування предметів першої необхідності по всьому світу. З моменту його появи в сфері охорони здоров'я вчені намагалися розглянути вплив дронів на охорону здоров'я в Африці і світі в цілому. Серед іншого, вчені з'ясували, що пристрій здатний долати погодні обмеження, брак персоналу в недоступних місцях в секторі охорони здоров'я. Незважаючи на це, даних про дрони і їх застосуванні в Гані, в секторі охорони здоров'я, зокрема, мало представлені в літературі. Крім того, вчені не робили особливих спроб висвітлити використання дронів в африканських країнах. У цьому дослідженні робиться спроба заповнити вказаний вище пробіл, використовуючи підхід описового огляду. При такому підході було проведено ретельний пошук літератури для пошуку і оцінки наукових матеріалів, що стосуються застосування дронів у військовій області і, зокрема, в медичних системах Африки і Гани. Несучи одноосібну відповідальність за доставку*

предметів, зацікавлені сторони в області охорони здоров'я, в декількох частинах світу покладалися на безпілотні літальні апарати для транспортування життєво важливих предметів у медичні центри. Такі країни, як Сенегал, Мадагаскар, Руанда і Малаві, закликали Гану розглянути питання про застосування дронів в її основних медичних послугах. Результати дослідження показали, що прийняття Ганою політики використання безпілотних літальних апаратів, поліпшило своєчасну доставку таких продуктів, як зразки для аналізу, крові і засоби індивідуального захисту, в різні медичні центри і, зокрема, в сільські райони. Дрони внесли свій вклад в забезпечення медичної допомоги в Гані. Ми прийшли до висновку, що завдяки політиці безпілотних літальних апаратів континент має тенденцію досягати успіхів щодо зменшення надмірно збільшившогося розриву в сфері охорони здоров'я між сільським і міським населенням.

**Ключові слова:** *дрони; медичні безпілотники; Африка; Гана; безпілотні літальні апарати; безпілотна повітряна система*

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## Историзация медицинских дронов в Африке: в центре внимания Гана

**Аннотация.** *Хотя происхождение технологии работы дронов до конца не изучено, понятно одно: они возникли как военный аппарат и привлекли большое внимание во время крупных войн, включая две мировые войны. Помимо использования в боевых действиях и для оказания гуманитарных услуг, дроны также широко использовались для уничтожения как солдат, так и мирных жителей. Революционная технология дронов была усовершенствована в XIX веке, появилась возможность ими управлять как беспилотными летательными аппаратами, предназначенными главным образом для нацеливания на войска. Новая развивающаяся область применения беспилотных летательных аппаратов – это сектор здравоохранения. С годами сектор здравоохранения все больше полагается на устройства для своевременной транспортировки предметов первой необходимости по всему миру. С момента его появления в сфере здравоохранения ученые пытались рассмотреть влияние дронов на здравоохранение в Африке и мире в целом. Среди прочего, ученые выяснили, что устройство способно преодолевать погодные ограничения, нехватку персонала*

*в недоступных местах в секторе здравоохранения. Несмотря на это, данных о дронах и их применении в Гане, в секторе здравоохранения, в частности, мало представлены в литературе. Кроме того, ученые не предпринимали особых попыток осветить использование дронов в африканских странах. В настоящем исследовании делается попытка восполнить указанный выше пробел, используя подход описательного обзора. При таком подходе был проведен тщательный поиск литературы для поиска и оценки научных материалов, касающихся применения дронов в военной области и, в частности, в медицинских системах Африки и Ганы. Неся единоличную ответственность за доставку предметов, заинтересованные стороны в области здравоохранения в нескольких частях мира полагались на беспилотные летательные аппараты для транспортировки жизненно важных предметов в медицинские центры. Такие страны, как Сенегал, Мадагаскар, Руанда и Малави, призвали Гану рассмотреть вопрос о применении дронов в ее основных медицинских услугах. Результаты исследования показали, что принятие Ганой политики использования беспилотных летательных аппаратов, улучшило своевременную доставку таких продуктов, как образцы для анализа, кровь и средства индивидуальной защиты, в различные медицинские центры и, в частности, в сельские районы. Дроны внесли свой вклад в обеспечение медицинской помощи в Гане. Мы пришли к выводу, что благодаря политике беспилотных летательных аппаратов континент имеет тенденцию добиваться успехов в отношении чрезмерно увеличившегося разрыва в сфере здравоохранения между сельским и городским населением.*

***Ключевые слова:*** *дроны; медицинские беспилотники; Африка; Гана; беспилотные летательные аппараты; беспилотная воздушная система*