

**KNOWLEDGE AND AWARENESS OF THE USE OF DRONE IN MEDICAL  
FACILITIES AMONG HOSPITAL STAFF IN BENIN CITY**



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**A PROJECT SUBMITTED TO THE DEPARTMENT OF MEDICAL LABORATORY  
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BACHELOR OF MEDICAL LABORATORY SCIENCE (BMLS) DEGREE IN THE  
DEPARTMENT OF MEDICAL LABORATORY SCIENCE**

**SEPTEMBER, 2025.**

## DECLARATION

I hereby declare that this project work titled “**Knowledge and Awareness of the Use of Drone in Medical Facilities among Hospital Staff in Benin City**” was conducted under my supervision and has not been submitted in part or in full for any purpose.

**CERTIFICATION**

This is to certify that this project write up is an authentic work carried out by **AMEGOR OSASUMWEN CALEB** with matriculation number **BMS2001151** under the supervision of **PROF.. B. I. G Adejumo** in partial fulfillment of the requirement for the award of Bachelor of Medical Laboratory Science (BMLS) Degree of the Department of Medical Laboratory Science, School of Basic Medical Science, University of Benin, Ugbowo, Benin City, Edo state.

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**DATE**

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**DATE**

## **DEDICATION**

I dedicate this project to God Almighty for making this project work a huge success.

## **ACKNOWLEDGEMENTS**

I give thanks to God Almighty for his grace upon my life and for seeing me through this project work.

My profound gratitude goes to my supervisor Prof. B. I. G Adejumo for his love, concern, constructive and supportive idea which has aided this project work.

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## ABSTRACT

Unmanned aerial vehicles (UAVs), commonly known as drones, have emerged as a transformative technology in healthcare delivery, particularly for improving logistics in resource-limited settings. Despite their potential to address delays caused by poor infrastructure and traffic congestion, their successful implementation depends largely on the awareness, knowledge, and acceptance of healthcare workers. This study therefore aimed to assess the knowledge and awareness of drone use in medical facilities among hospital staff in Benin City, Edo State, Nigeria. A cross-sectional descriptive survey design was adopted, involving one hundred and fifty-three (153) hospital staff comprising doctors, nurses, pharmacists, laboratory scientists, logistics personnel, and administrators at the University of Benin Teaching Hospital (UBTH). Data were collected using a structured 23-item questionnaire covering demographics, awareness, knowledge, and perceptions of drone use in healthcare. Responses were analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0, with Chi-square tests applied at a significance level of  $p < 0.05$ . The results showed that 65.1% of respondents had heard of drones being used in healthcare, and 65.8% were aware of their application in delivering medical supplies. However, only 9.9% had practical exposure by visiting a facility where drones were in use. A large majority (93.4%) believed that drones could improve the delivery of medical supplies in hospitals, and 73.0% supported their use for rural healthcare delivery. Furthermore, 53.3% expressed high willingness and 32.2% moderate willingness to receive training in drone technology. Despite this positive outlook, knowledge gaps were observed, as 59.8% of participants could not correctly define UAV. In conclusion, this study revealed moderate awareness but limited knowledge of drone applications in healthcare among hospital staff in Benin City. Although exposure to real-life drone operations was low, the strong willingness to receive training highlights an opportunity to promote adoption. These findings underscore the need for targeted training, policy support, and pilot projects to bridge knowledge gaps and harness drone technology for healthcare delivery in Nigeria.

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background to the Study

Unmanned aerial vehicles (UAVs) or UAS Unmanned Aircraft Systems, commonly known as drones, have emerged as a transformative technology in healthcare delivery, offering innovative solutions to logistical challenges in medical supply chains (Austin, 2010). Drones are aircraft operated without a human pilot onboard, controlled either remotely by a human operator or autonomously through pre-programmed software and onboard sensors (Clarke, 2014). Drones are equipped with technologies such as GPS, cameras, and communication systems, enabling them to perform tasks ranging from surveillance to transportation (Rao *et al.*, 2016). Drones facilitate the rapid transport of critical medical supplies, such as blood products, vaccines, diagnostic samples, and emergency medications, particularly to remote or underserved regions (Nyaaba and Ayamga, 2021).

In sub-Saharan Africa, where geographical barriers, poor road infrastructure, and limited healthcare resources often impede timely medical access, drones have demonstrated significant potential to improve health outcomes (Olatunji *et al.*, 2023). In Nigeria, cities like Benin City face healthcare delivery challenges, including traffic congestion, delayed emergency responses, and uneven distribution of medical resources, which drones could potentially address (Amukele *et al.*, 2016). Drones have demonstrated efficiency in reducing delivery times, as evidenced by a study in Kenya where drones covered 12 km in 20 minutes compared to an hour by vehicle or up to five hours on foot in remote areas (Bhatt *et al.*, 2024). Despite these advantages, the adoption of drone technology in Benin City's healthcare sector remains limited, with minimal documented implementation (Eichleay *et al.*, 2019). The successful integration of drones into medical

facilities hinges on the knowledge, awareness, and acceptance of hospital staff, who are essential for operationalizing drone-based delivery systems (Roslan and Shah, 2023). Research indicates that healthcare workers' understanding of drone applications, their perceptions of benefits, and concerns about safety, privacy, and reliability significantly influence adoption rates (Jeyabalan *et al.*, 2020)

In Benin City, there is a scarcity of data on hospital staff's knowledge and awareness of drone use in medical facilities (Ameso *et al.*, 2024). Understanding these factors is critical, as healthcare professionals are responsible for integrating drone-delivered supplies into clinical workflows, from ordering to handling payloads (Knoblauch *et al.*, 2023). Factors such as prior exposure to drone technology, institutional support, and training opportunities are likely to shape staff attitudes and readiness to adopt this innovation (Scott and Scott, 2017). Additionally, contextual factors, including community perceptions and Nigeria's regulatory framework for drones, may influence staff perspectives, as observed in Uganda, where community engagement was vital for acceptance (Ssekitoleko *et al.*, 2024). Given the potential of drones to address healthcare delivery challenges in Nigeria and the global trend toward their adoption, assessing the knowledge and awareness of hospital staff in Benin City is a crucial step toward evaluating the feasibility of drone integration (Ameso and Mwonzora, 2024).

## **1.2 Statement of Problem**

A critical barrier to the successful implementation of drone technology in healthcare is the lack of awareness and knowledge among hospital staff, who are essential stakeholders in operationalizing and advocating for such innovations (Knoblauch *et al.*, 2019).

Studies in similar contexts, such as India, have shown that 57% of healthcare workers were unaware of drone applications in healthcare, highlighting potential knowledge gaps that could impede technology acceptance and integration (Sharma, 2022).

In Benin City, there is a paucity of data on the extent to which hospital staff, including doctors, nurses, pharmacists, laboratory scientists, and administrators, are aware of or knowledgeable about the potential applications of drones in medical facilities. This knowledge gap poses a significant challenge to the feasibility of introducing drone technology in Benin City's healthcare system. Without understanding the current level of awareness and knowledge among hospital staff, it is difficult to design targeted training programs, address perception barriers, or develop policies to support drone adoption (Knoblauch *et al.*, 2019).

Furthermore, the absence of empirical data on this topic limits the ability of stakeholders, including hospital management and policymakers, to make informed decisions about investing in drone-based healthcare solutions (Balasingam, 2017).

This study aims to investigate the level of awareness, knowledge, and perceptions of hospital staff regarding the use of drones in medical facilities, identifying barriers and facilitators to inform future implementation strategies. By addressing these knowledge gaps, this research seeks to contribute to the evidence base for leveraging drone technology to enhance healthcare delivery in Nigeria's urban settings (Gangwal *et al.*, 2019).

### **1.3. Justification of the Study**

This study is justified by the need to fill the critical knowledge gap of assessing the awareness and knowledge of drone use among hospital staff in Benin City. The findings will provide valuable insights into the current level of understanding, identify perception barriers, and

highlight areas where targeted educational interventions are needed to facilitate technology adoption. Furthermore, the study will inform hospital administrators, policymakers, and technology providers about the readiness of healthcare workers to embrace drone technology, thereby supporting evidence-based strategies for integrating drones into Nigeria's healthcare system and also contributing to improvement of healthcare delivery efficiency, enhancing emergency response capabilities, and ultimately improving patient outcomes in Benin City.

### **1.3 Aim of the Study**

This study aims to assess the knowledge and awareness of drone use in medical facilities among hospital staff in Benin City.

### **1.4 Specific Objectives**

1. to assess the level of awareness of drone technology and its applications in healthcare among hospital staff in Benin City.
2. to evaluate the knowledge of hospital staff regarding the operational and clinical benefits of drone technology in medical facilities.
3. to determine the perceptions and attitudes of hospital staff toward the adoption of drone technology in medical facilities.

### **1.5 Research Question**

1. What is the level of awareness of drone technology and its applications in healthcare among hospital staff in Benin City?
2. How knowledgeable are hospital staff in Benin City about the operational and clinical benefits of drone technology in medical facilities?

3. What are the perceptions and attitudes of hospital staff in Benin City toward the adoption of drone technology in medical facilities?

## **1.6 Research Hypothesis**

### **1.6.1 Null Hypothesis (H0):**

- There is no significant difference in the level of awareness of drones and its application in healthcare among hospital staff in Benin City.
- Hospital staff in Benin City have no significant knowledge regarding the operational and clinical benefits of drone technology in medical facilities.
- There are no significant differences in the perceptions and attitudes of hospital staff toward the adoption of drone technology in medical facilities

### **1.6.2 Alternative Hypothesis (H1):**

- There is a significant difference in the level of awareness of drone technology and its applications in healthcare among hospital staff in Benin City.
- Hospital staff in Benin City have significant knowledge regarding the operational and clinical benefits of drone technology in medical facilities.
- There are significant differences in the perceptions and attitudes of hospital staff toward the adoption of drone technology in medical facilities.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Knowledge

Knowledge is the consciousness of knowing about something, and it is applied for the development of humankind. It is created in the human minds and increases when people are involved in its acquisition and dissemination. Hence, previous knowledge enhances the formation of developed and advanced knowledge (Nasimi *et al.*, 2013). Knowledge is built up from data, information and prior knowledge. Data refer to raw facts without any processing, organizing or analysis, and hence they have little meaning and few benefits to decision-making. Again, knowledge is organized information that changes something or somebody; either by being foundations for action, or by creating an individual (or an institution) capable of different successful action (Drucker, 1989; Brooking, 1999). We can transform information into knowledge by the accumulation of meaning and determining what action should be taken (Gill, 2000). Knowledge is derived from information but it is more meaningful than information (Servin and De Brun, 2005). Knowledge is essential for the solution of problem and decision making, because it contains stronger meaning than data and information (Davenport, 1997).

At present, knowledge has become one of the best sources of competitive advantage for an organization. We can say, knowledge is the nominalization of the mental process of “knowing”. Knowledge can be classified into four ways as: personal, shared and public, hard and soft, practical and theoretical, forefront and backdrop, and internal and external (Pathirage *et al.*, 2008). But most commonly we can divide it into two parts:

- i. Explicit knowledge, and
- ii. Tacit knowledge (Nonaka and Takeuchi, 1995).

Tacit knowledge (TK) represents experiential understanding that cannot easily be codified or transmitted through formal artifacts. It is estimated that approximately 80% of human knowledge is tacit, while only about 20% is explicit (Mohajan, 2016). Tacit knowledge is subjective and intangible knowledge which is intuitive and difficult to express and practice with language, diagrams, figures, or numbers (Magnier-Watanabe *et al.*, 2011). The term tacit knowledge is originally named by Polanyi (1966). Polanyi referred to the tacit influence of the mind by which all knowledge is discovered and then held to be true. It comes from the individual's mind and is founded on life experiences, reading, learning, environment, beliefs, points of view, technical skills, and other background characteristics (Ekore, 2014). Explicit (codified) knowledge (EK) can be verbally explained (in formal and systemic language), codified it through many sorts of data that can be stored, and written down in specified documents. It is objective and rational and can be expressed with language, numbers, or formulas. It involves know-how that is transmittable in formal and systematic language and can be stored and disseminated with technology (Magnier-Watanabe *et al.*, 2011; Ekore, 2014). It is easily codified, storable, transferable, and easily expressed and shared (Serban and Luan, 2003). Sources of Explicit knowledge are manuals, policies and procedures, and databases and reports (Serban and Luan, 2003).

## **2.2 Awareness**

Awareness can be understood as knowledge that stems from perception. It is influenced not only by one's personal experiences but also by the surrounding environment. Rather than being tied to every decision or constant focus, awareness emerges when individuals deliberately pay attention to the present moment in an open and non-judgmental manner toward their lived experiences (Jauriyah, 2020).

In addition, awareness plays a role in decision-making by combining implicit understanding, rational thought, and emotional responses, helping individuals adapt their behavior to achieve better outcomes (Zhou & Guo, 2025). Still, awareness should not be equated with total conscious control. Self-reports are often influenced by bias, and certain stimuli may guide behavior without ever reaching conscious awareness. This gap between what is consciously reported and what operates outside awareness highlights the methodological difficulties in examining awareness and its significance for communication and health outcomes (Merikle, 1984; McDonald, 2012). Researchers distinguish between two main types of awareness: internal and external. Internal awareness relates to acknowledging emotions, thoughts, or physical states, whereas external awareness involves recognizing environmental factors and social signals (McDonald, 2012). The depth of awareness may vary from basic sensory detection to reflective processes where people not only perceive stimuli but also assess and interpret them (Morin, 2011).

### **2.3 Drones**

A drone, or Unmanned Aerial Vehicle (UAV), is an aircraft operated without a human pilot onboard, controlled either remotely by a human operator or autonomously through pre-programmed software and onboard sensors (Clarke, 2014). Previously there were known as “pilotless aircraft” (Mirza *et al.*, 2016), Drones are equipped with technologies such as GPS, cameras, and communication systems, enabling them to perform tasks ranging from surveillance to transportation (Rao *et al.*, 2016). In the context of healthcare, drones are defined as aerial platforms designed to transport medical supplies, collect data, or support emergency response, leveraging their ability to navigate challenging terrains and deliver payloads with precision (Thiels *et al.*, 2015). Drones have triggered a swift advancement in a variety of commercial, recreational and industrial services with the capability to put together real time data cost

effectively as well as transport air cargo. However, its breakthrough in healthcare has been slower compared to other sectors where drones have been used extensively. Overall, drones have the capability to evolve medical care and propel advancement in the health industry (Adejumo *et al.*, 2021).

### 2.3.1 Structure of a Drone

The structure of a drone comprises several key components that enable its functionality. The airframe, typically made of lightweight materials like carbon fiber or aluminum, provides structural integrity and aerodynamic efficiency (Nonami *et al.*, 2010). Propulsion systems, including motors and propellers, generate lift and thrust, while batteries (often lithium-ion) power the drone, with flight times ranging from 20 to 60 minutes depending on the model (Gupta *et al.*, 2013). In addition, gyroscopes and other sensors are added to increase the mid-air stability of the drone and a GPS device can be used for navigation (Cummings *et al.*, 2007). Onboard sensors, including cameras and thermal imaging devices, collect data, while communication systems like radio or satellite links enable real-time control and telemetry (Sharma, 2022).

<b>Components</b>	<b>Function</b>	<b>Importance</b>
Air Frame	Holds all components	Structural integrity
Motors	Propel and stabilize the drone	Essential for flight
Propeller	Create Lift and thrust	Directly affects flight dynamics
Flight Controller	Manages all aspects of flight	Brain of the drone
Battery	Powers the drone	Determines flight time
Sensor	Provide data on position	Navigation and stability
GPS Module	Enhances navigation	Precise positioning
Camera	Captures Image and Videos	Essential for aerial photography

Table 2.1 Components of a drone, their functions and importance

In medical drones, payload compartments are often equipped with temperature-controlled insulation to protect sensitive items like vaccines or blood samples (Pulver *et al.*, 2016). These components collectively enable drones to perform complex tasks in healthcare settings.



Figure 2.1 Structure of a commercial drone *Source: (Rao et al., 2016)*

### 2.3.2 Types of Drones

Drones are classified based on their design, propulsion, and intended use, with several types relevant to healthcare applications:

- **Multi-Rotor Drones:** Characterized by multiple propellers (e.g., quadcopters, hexacopters), these drones provide vertical takeoff and landing capabilities, making them suitable for short-range deliveries in urban environments where maneuverability is critical (Naor *et al.*, 2024). They are commonly used for transporting lightweight payloads like diagnostic samples (Figure 2.2A). Amongst other types of drones, the multi rotor drone is the most predominantly used by amateurs, professionals, hobbyists and

drone enthusiasts with similar interest. They are mostly utilized in conventional activities such as aeronautic videography and photography as well as in surveillance. Albeit somewhat cheap and simple to build, multi rotor drone has a number of drawbacks. The well-known downsides are its circumscribed speed, flying time and endurance making it unsuitable for wide-reaching projects that requires long haul flying (Adejumo *et al.*, 2021). The major problem associated with the multicopters is that they spend a great amount of their energy trying to balance themselves in the air and oppose gravitation. This however probably exhausts the battery that would have been channeled into their flying time. Notwithstanding, their ability to remain still in air makes them useful in aerial photography and other applications that require hovering in the air for a long period of time. As of now, a good number of the multi rotor drones available have a flying time of about 20 to 30 minutes and can mostly afford to fly a light weighted air cargo as in a camera (CircuitsToday, 2018).

- **Fixed-Wing Drones:** These drones resemble small airplanes, offering long-range capabilities and extended flight times (up to several hours) due to their aerodynamic efficiency (Nonami *et al.*, 2010). Fixed wing drones are built differently and also differ completely in terms of design (Figure 2.2B). Just like normal manned aircrafts, they have wings and with regards to flying and air control, fixed wing drones do not exhaust their energy trying to remain balanced in the air opposing gravitation unlike the multi-rotor drones. Fixed wing drones cannot remain still on the air rather they fly progressively under the guidance of a remote controller within the set time the energy life allows (Adejumo *et al.*, 2021). They are ideal for delivering medical supplies to remote areas, as seen in Zipline's operations in Rwanda (UNICEF, 2023).

- **Single-Rotor Drones:** Single rotor drones like the name implies, have only one big sized rotor and a small sized rotor at the extremity of the drone to help navigate its direction. Unlike the multi rotor models, they are more efficient and productive with a higher-flying time and can be energized by gas engines (Figure 2.2C). Their appearance, structure and built closely resembles that of a real-life helicopter. The complexities and operational risks associated with these single rotor drones are however more advanced. They are also more expensive and require professional training to fly them appropriately in air although a runway or a catapult launcher may not be required to launch them on air. Similar to helicopters, these drones rotors, offer stability but higher energy consumption, limiting their use in medical applications (Sharma, 2018).
- **Hybrid Drones:** Combining fixed-wing and multi-rotor features, the rotor models in terms of their ability to remain still in air while the fixed wing models for their higher-flying time (Figure 2.2D). They are characterized of both manual gliding and automation. For the manual, it utilizes a remote based manual control which may also be programmed to navigate the drone on a set course or direction. Whilst the automation consists of the gyros and accelerometers that utilizes the autopilot concept (automated mode) to ensure the drone stability in air (Adejumo *et al.*, 2021).. Hybrid drones offer versatility for both long-range and precise operations, suitable for mixed urban-rural settings (Gupta *et al.*, 2013). They are emerging in healthcare for flexible delivery routes.

In healthcare, multi-rotor and fixed-wing drones are the most prevalent due to their adaptability to urban and rural environments, respectively (UNICEF, 2023).



Figure 2.2: Types of drones currently in use: A (Multi Rotor), B (Fixed Wing), C (Single Rotor) and D (Hybrid). *Source:* CircuitsToday, 2018.

## 2.4 Evolution and Technology of Drones

The evolution of drones began in the early 20th century with military applications, such as the 1918 Kettering Bug, a pilotless bomb used during World War I (Keane and Carr, 2013). By the 1980s, advancements in microelectronics and GPS enabled civilian applications, with drones becoming commercially viable in the 2000s (Nonami *et al.*, 2010). Modern drones incorporate technologies like AI-driven navigation, lightweight composite materials, and high-capacity batteries, enhancing their range, payload capacity, and autonomy (Gupta *et al.*, 2013). According to *Handbook of Unmanned Aerial Vehicle: Emerging Technologies* (Valavanis and Vachtsevanos, 2015), recent innovations include obstacle avoidance systems, real-time data processing, and improved communication protocols, making drones suitable for complex tasks in

diverse environments. Nowadays, drones are serving various purposes (Qureshi *et al.*,2021). Portable drones for delivery purpose are no more a dream now.

#### **2.4.1 Evolution and Technology of Drones in Healthcare**

The application of drones in healthcare emerged in the early 2010s with pilot projects testing their ability to deliver medical supplies in remote areas (Pulver *et al.*, 2016). Technological advancements have since tailored drones for medical use, incorporating features like temperature-controlled payload compartments to maintain the cold chain for vaccines and blood products (Amukele *et al.*, 2016). Medical drones use AI and GPS for autonomous navigation, ensuring safe delivery in challenging terrains (Choi and Kim, 2015). For example, Zipline's drones in Rwanda employ real-time telemetry and tamper-proof containers to deliver blood within 30 minutes, a significant improvement over ground transport (UNICEF, 2023). Research by Claesson *et al.*, (2016) highlights that medical drones are equipped with thermal sensors and secure payload systems to protect sensitive materials, addressing challenges like spoilage or contamination.

Previous literature (Rosser *et al.*, 2018) suggests that even with increasing adoption and maturation of drone technology in various fields, their development within the biomedical area is still slower as compared to other civil uses (Qureshi *et al.*,2021). This is because, most of the time, there is urgency associated with the clinical circumstance, where location, time, and the date are the factors that don't permit control (Rosser *et al.*, 2018). Rules and regulations are also imposing many restrictions on the field of healthcare. The potential areas for the application of drones in public health are filming accidents and medical services being provided, assessment of the patients in disasters, secure and search missions, and where drones can assist in remote telemedicine and patient care at home (Magnusson *et al.*, 2019).

## 2.5 Application of Drones in Medical Facilities

Drones have transformative applications in medical facilities, addressing logistical, emergency, and surveillance needs. The primary application is the delivery of medical supplies, such as blood, vaccines, medications, and diagnostic samples, to remote or underserved areas (*Pulver et al.*, 2016). In Rwanda, Zipline's drone network has delivered over 1 million medical products since 2016, reducing blood delivery times and improving maternal health outcomes (Zipline, 2025). In Ghana, drones have transported millions of vaccine doses, addressing stock outs in rural areas (UNICEF, 2023). Drones also support emergency response by delivering automated external defibrillators (AEDs) for cardiac emergencies and providing supplies during natural disasters (*Claesson et al.*, 2016). A study in Resuscitation found that drones delivered AEDs faster than ambulances in urban settings, reducing response times by up to 50% (*Claesson et al.*, 2016). Additionally, drones facilitate telemedicine by deploying telecommunication equipment for remote diagnostics and support public health surveillance by collecting environmental data to monitor diseases like malaria (Scott and Scott, 2017). These applications highlight drones' versatility in enhancing healthcare delivery.

Medical goods that can be carried and delivered through the drones can be non-biological and biological material. These include laboratory samples, blood and transplantation material, sterile goods, medicine, and other pharmaceuticals, and various medical devices (*Qureshi et al.*, 2021). An example of the drone assisted medical goods is the supply of blood and related products to the far rural areas by using drones (*Qureshi et al.*, 2021). Since 2011, the on-demand blood supply to the various regional health centers is being performed by a company Zipline working with the Rwanda government (*Magnusson et al.*, 2019). In Tanzania and Rwanda, the Provision

of medicine and vaccine to various clinics is being carried by many drones on a daily basis (Magnusson *et al.*, 2019).

Lab samples are among common medical goods that are and are planned to be delivered by the medical drones in many projects (Qureshi *et al.*,2021). One of the benefits of the drone-assisted lab samples is that it will save the time of transportation that is very important for the laboratory procedures as well as for the physicians to carry out or plan a treatment therapy (Mion, 2019).

Name of company	Items to be delivered	Location to be delivered
Delft University	Defibrillators	Netherlands
Zipline	Vaccines, blood	Rwanda
DHL	Vaccines, Medical equipment	Germany
Wing copter	Lab samples, vital medical supplies	USA

Table 2.2 Existing Medical delivery drone companies *Source:* (Magnusson *et al.*, 2019).

## 2.6 Benefits of Drone Technology in Healthcare.

One of the essential benefits of the biomedical drone is its ability to provide rapid delivery, reducing transport times for time-sensitive supplies by up to 60% compared to traditional methods (Ling and Draghic, 2019). A drone can reach the patients in a radius of 4.6 mile<sup>2</sup> within a minute, which is ten times faster if compare with traditional emergency services (Qureshi *et al.*,2021). This speed is critical for emergencies like blood transfusions or organ transport (Amukele *et al.*, 2016). In terms of economy, they are cost-efficient alternatives, especially in the areas with difficult terrains, with Zipline reporting a 50% reduction in logistics costs for blood deliveries in Rwanda (Zipline, 2025). They enhance access to healthcare in underserved regions, bypassing geographical barriers like poor roads or rivers (Pulver *et al.*, 2016). One of the factors that worsened the West African Ebola outbreak was the poor roads that hindered the transport of

biological samples (WHO, 2015; Fayia EM III, 2014). While the problem of poor road access is not new or unique to West Africa, there is now a relatively inexpensive solution with a relatively low barrier to implementation (Amukele *et al.*, 2016). A simulation model has illustrated that drones could enhance the availability of vaccines with the associated reduction in the costs (Haidari *et al.*, 2016). Drones provide more accurate data because of their flight near to the earth's surface, and ultimately, they decrease the limitations linked with satellite images, for example, cloud contamination (Fornace *et al.*, 2016). Drones can be used in difficult areas such as snow-covered grounds, canyons, or mountains, and can assist the rescue squads in searching and documenting operations (Karaca *et al.*, 2018). Drones also reduce human error through automated systems and produce lower carbon emissions than traditional vehicles, aligning with sustainability goals (Keane and Carr, 2013).

## **2.7 Challenges and Limitations (Drawbacks associated with biomedical drones)**

Certain limitations do exist for using drones in the area of public health, such as

### **2.7.1 Infrastructure and human resources**

A skilled workforce and constant supervision from the ground is needed to operate a drone. Structure related issues such as the unavailability of runway can be a potential issue in this regard. However, it can be compensated by employing the drone having the ability of vertical landing and takeoff. Furthermore, the utility of medical drones can be a reason for the downsizing of the employee in the industry related to medical supply. However, it will produce opportunities as well by creating space for drone operators (Laksham *et al.*, 2019).

### **2.7.2 Technical constraints**

In contrast with commercial helicopters and planes, drones are not able to transport the supplies over a long distance or carry heavy payloads. The approximate load carrying capacity of a drone is ranged between two to four kilograms (Scott and Scott, 2017). The smarter a drone, its cost, and weight will be increased. Likewise, the efficiency and safety of the drones are not well established yet. Biological items are far more sensitive and fragile and require proper care and package to avoid tampering during transit (Qureshi *et al.*, 2021). Moreover, the transportation of vaccines and drugs by drones require coolers and ice packs to be pre-installed in the drones to ensure the cold chain. Another technical issue linked with medical drones is its battery life, which can be managed by providing solar energy like Aquila by Facebook (Zuckerberg, 2016). Furthermore, return to the safe point can be ensured by the programming of the drone in case if there is any communication problem or their battery is low. Drones' tolerance to the harsh environment, such as turbulence and wind, is also unclear and not established yet. Electromagnetic waves interruptions also disturb the normal drone's operation from the ground (Abrahamsen *et al.*, 2015).

### **2.7.3 Regulations and legal concerns**

Drone being a newly emerging technology has created many important regulatory challenges. Different regulatory regimes are still evolving for the drones at the domestic and international level. Regulatory restrictions, particularly on beyond visual line of sight (BVLOS) operations, limit scalability in countries like Nigeria, where airspace regulations are stringent (Scott and Scott, 2017). Technical limitations, such as battery life (20–60 minutes) and payload capacity (typically under 5 kg), restrict delivery range and volume (Nonami *et al.*, 2010). In the united stated, license to operate to the unmanned aerial vehicle is awarded under Federal Aviation Administration rules. And this permission is subjected to the weight, i.e., less than 25 kilograms,

territory, i.e., it will fly within a visual line of sight, and its altitude and speed, i.e., maximum height can be 400 feet above the ground. The maximum permitted speed is 100 miles per hour (AFA, 2016).

Additionally, Public perception is a significant barrier, with drones often associated with military use or privacy concerns (Claesson *et al.*, 2016). A study in Aerospace Science and Technology reported that 25% of healthcare professionals expressed concerns about drone safety, citing risks like crashes or payload damage (Hassanalian and Abdelkefi, 2017). High initial costs for drone infrastructure, including training and maintenance, are prohibitive in low-resource settings like Nigeria (Ling and Draghic, 2019). These challenges necessitate regulatory reforms, technological advancements, and public engagement.

## **2.8 Future Use of Drone**

There are various potential uses of biomedical drones in the field of public health, and its applications are expanding. Some of the opportunities can be;

### **2.8.1 Transportation of biological consumables, medicines, and blood**

In developing and underdeveloped countries, safe blood is deficient in areas with difficult accessibility. Blood can be transported from the blood banks to remote healthcare facilities by using the drones in specific emergencies such as during parturition or other surgeries. This will save costs by avoiding the need to set up a blood bank in remote areas. These drones can also be used in massive casualties situations such as in natural disasters and other tragic incidents (Wen T *et al.*, 2016). The Government of Rwanda is using drones to transport blood to the clinic situated in hard to reach locations in the cost of motorbike deliver and comparably in less time (Qureshi *et al.*, 2021).

In villages and remote areas, delayed diagnosis of the disease is a common issue due to the unavailability of the laboratory facilities. This issue can be avoided by using drones for the transportation of diagnostic aids and samples. Health care personnel can be trained for the collection and transportation of the samples to the nearby laboratory with the help of drones. Furthermore, the results and associated medicines can be sent back if the results are positive. Previously drones have been used to collect blood samples from the areas with no laboratory facilities in Madagascar (Laksham *et al.*,2019). Drones can also be used for the delivery of essential medicines such as anti-venom and other post-exposure vaccines for the dog and snake bites to prevent the casualties which are much common in rural areas (WHO, 2016).

### **2.8.2 Disaster relief and medical emergencies**

In disaster management operations, drones can be used to rescue the victims from the disaster areas such as collapsed buildings or in seas where fishers lost. Drones can further used for the transportation of medicine, water, and food in any disaster situation and to the patients who are on offshore ships. A drone can have the potential to be used as an ambulance during emergencies. Drones can supply devices like AED (Automated External Defibrillator) to the cardiac arrest patient in the area with no hospital facility within a short time, which can enhance the chances of survival (Aaron *et al.*, 2018). Drones equipped with AED can provide visual feedback and help a bystander in cardiopulmonary resuscitation of the cardiac arrest patient. Drones delivering real-time videos are efficient and time-saving in locating drowning persons and the provision of flotation devices in comparison to surf lifeguards (Seguin *et al.*, 2018).

### **2.8.3 Organ transplantation**

One of the main hurdles in the organ transplantation sector is the transportation of donated organs from the harvesting facility to the transplantation hospital with the least possible time.

Traditionally, in many countries, the traffic police department forms a green passageway for the vehicle carrying donated organs by blocking the other everyday traffic. Donated organs can be delivered within the possible shortest time by using the drones, avoiding densely populated roads. Drones assisted kidney transportation did not show any significant damage by the extrinsic forces (Scalea *et al.*, 2019).

#### **2.8.4 Surveillance in hard areas**

Many surveys can be conducted under challenging areas within a short time by using the drones, which may become otherwise inaccessible by ground. Back in March 2011, radioactive material was spread in the environment of Fukushima, Japan, due to tsunami and earthquakes. Drones equipped with a gamma spectrometer were used to illustrate nuclear contamination and to create resolution maps of contamination (Lum *et al.*, 2007)

#### **2.8.5 Role in pandemic/epidemic like COVID-19**

Recent work has analyzed the COVID-19 pandemic, drone-based systems, and proposed mechanisms for managing pandemic circumstances in various scenarios by using real-time and simulation-based studies. This study recommended architecture applies wearable devices to track the observations in body area networks in a pull-push data fetching mechanism. This mechanism is revealed to be helpful in highly congested and remote pandemic regions where COVID-19 spread chances are high or where internet connectivity is a significant problem. It gathers, stores, and analyzes a considerable amount of data within a given time frame and assists in taking suitable measures as and when needed (Kumar *et al.*, 2020). It is observed that a real-time drone-based healthcare system for COVID-19 operation can cover a vast area for thermal image collection, patient identification, sanitization within a short time, that is, 2 kilometers in about ten

minutes by. Furthermore, collision-resistant strategies are also found working effectively for outdoor and indoor healthcare operations (Kumar *et al.*, 2020).

## **2.9 Knowledge and Awareness among Healthcare Professionals**

The successful integration of drones into medical facilities depends on healthcare professionals' knowledge and awareness. Research indicates that awareness varies widely, influenced by education, exposure, and cultural perceptions (Scott and Scott, 2017). A Swedish study found that 55% of emergency medical personnel were aware of drone applications, but only 20% felt confident in their operational use due to limited training (Claesson *et al.*, 2016). In developing countries, awareness is lower. A survey in India reported that only 15% of rural healthcare workers were familiar with drone technology, despite its potential to address logistical challenges (Jeyabalan *et al.*, 2020). Misconceptions, such as associating drones with surveillance, reduce acceptance among professionals (Hassanalian and Abdelkefi, 2017). In Malaysia, a study found that while 70% of healthcare workers supported drone use, only 35% understood their operations, citing lack of exposure as a barrier (Jeyabalan *et al.*, 2020). These findings underscore the need for targeted education and training to enhance knowledge and acceptance.

## **2.10 Relevance of Drone Application to Benin City Healthcare Facilities**

Benin City, Nigeria, presents a compelling case for drone applications due to its urban congestion and surrounding semi-rural areas with poor road infrastructure (Nwankwo *et al.*, 2020). Traffic delays in the city hinder timely delivery of medical supplies, making drones a viable solution for bypassing road networks (Jeyabalan *et al.*, 2020). A pilot project in Kaduna State, Nigeria, demonstrated that drones reduced vaccine delivery times by 50% compared to ground transport (UNICEF, 2023). Awareness of medical-delivery drones among Nigerian primary-healthcare personnel is low; a June 2023 quantitative report found only 6% of

healthcare personnel spontaneously mentioned drones as an emerging technology in Primary Health Care (PHC) (GIZ-SEDIN, 2023). Drones could address logistical challenges in Benin City, such as delivering blood or medications to rural health centers or navigating urban traffic during emergencies (Ling and Draghic, 2019). However, cultural perceptions and limited exposure to technology may hinder acceptance among hospital staff, necessitating awareness campaigns (Scott and Scott, 2017). The success of drone programs in Rwanda and Ghana suggests that similar initiatives could transform healthcare delivery in Benin City, Nigeria and other West African Countries, provided knowledge gaps are addressed (Zipline, 2025).

## CHAPTER THREE

### MATERIALS AND METHODS

#### 3.1 Study Design

This study adopted a cross-sectional descriptive survey design to assess the knowledge and awareness of drone use in medical facilities among hospital staff in Benin City, Nigeria. A questionnaire-based approach was used to collect quantitative data from a sample of hospital staff, including medical doctors, nurses, pharmacists, scientists, logistics personnel, and administrators, across selected public and private hospitals. Questionnaires can be distributed to a large number of respondents simultaneously. Given that Drone technology and its application as regarding healthcare delivery is still emerging, questionnaire can serve as sufficient means of obtaining necessary information about its knowledge and awareness from healthcare practitioners. Quantitative data collected from questionnaires can be easily analyzed using statistical software, making it straightforward to identify trends, correlations and patterns. Results can be effectively presented through graphs and charts, enhancing the clarity of findings. A questionnaire-based approach allows for efficient, standardized data collection that is capable of capturing a wide range of information on knowledge, awareness and perceptions to yield quantifiable results.

#### 3.2 Study Area

This study was conducted among healthcare practitioners (Doctors, Nurses, Medical Laboratory Scientist, and other health hospital staff) in the University of Benin Teaching Hospital (UBTH) which is situated in Egor local government area, Benin City Edo State, Nigeria. The University of Benin Teaching Hospital is a prominent federal medical establishment in Benin City. The administrative headquarters of Egor Local Government Area is situated in Uselu. The population

of Egor LGA is about 340,287, amongst who are Doctors, Nurses, Medical Laboratory Scientists and other Health Practitioners. The Local Government Area (LGA) is partitioned into ten (10) Political/Administrative wards, namely Egor, Ebvareke, Evbuotubu, Ogida, Okhoro, Ugbowo, Useh, Uselu 1, Uselu 2 and Uwelu.

### **3.3 Study Participants**

A total of one hundred and fifty three hospital staff participated in the study, Doctors, Nurses, Scientists, and other Health Practitioners. A structured and segmented questionnaire was used to obtain demographic information such as age, sex, marital status, occupation, religion etc. Informed Consent was obtained from each participant after proper notification on the nature of the research, risks involved, benefit as well as its confidentiality. The ethics and research committee of the Ministry of Health and University of Benin Teaching Hospital approved this work.

#### **3.3.1 Inclusion Criteria**

- i. Hospital Staff- Participants must be employed as medical doctors, nurses, pharmacists, laboratory technologists, medical logistics and supply chain personnel, emergency medical service (EMS) staff, or hospital administrators
- ii. Staff who are directly or indirectly involved in clinical patient care, medical logistics, or hospital administration.
- iii. Consent: Participants must be willing to provide informed consent to participate in the questionnaire-based study.

### **3.3.2 Exclusion Criteria**

- i. **Non-Healthcare Staff:** Individuals employed in non-healthcare roles, such as security guards, cleaners, or maintenance workers, who do not involved in patient care or medical logistics.
- ii. **Irrelevant Roles:** Staff with no direct or indirect connection to clinical workflows, medical supply chains, or hospital operations (e.g., purely clerical staff without administrative responsibilities).
- iii. **Non-Consenting Individuals:** Staff who do not provide informed consent to participate in the study.

### **3.4 Ethical consideration**

Approval for this research was sought from the ethical committee of the Edo State Ministry of Health.

Informed consent was also acquired from all individuals who participated in the study, to capture their bio-data and other socio-demographic information

### **3.5 Data Collection**

A well-structured questionnaire, designed to assess knowledge, awareness, perceptions, and factors influencing drone use in medical facilities, was distributed to eligible participants involved in clinical, logistical, or administrative roles, and providing informed consent. Questionnaires will be administered in paper-based format, and distribution will occur over a 4–6 week period, Prior to distribution, the questionnaire will be pre-tested with a small group (e.g., 20 staff) from a non-selected hospital to ensure clarity and reliability. Completed questionnaires will be collected and stored securely, ensuring participant anonymity.

**3.5.1 Research Instrument (Questionnaire):** The study utilized a pre-tested 24 items questionnaire to obtain information about awareness, knowledge and perception of the use of drone in medical facilities in Benin City.

**3.5.2 Pretest:** The questionnaire were pre-tested in a sample (N = 20) of participants and necessary adjustments were made to suit the aims and objectives of the study.

**3.5.3 Section I - Demographics:** This portion of the questionnaire obtained information on sex, age, marital status, educational qualification, occupation and duration of working in their current hospital.

**3.5.4 Section II - Awareness of drone use in medical facilities:** This part of the questionnaire was used to determine the level of awareness of drone use, it is made up of 7 items with specific questions about awareness on the use of drones in medical facilities.

**3.5.5 Section III - Knowledge of drone use in medical facilities:** This part of the questionnaire specified on knowledge of drones; the meaning of unmanned aerial vehicle (UAV), can drones be used to deliver medical supplies to rural areas etc.

**3.5.6 Section IV - Perceptions and attitudes towards drone use:** This section included general perception and attitudes of the participants towards drone use.

**3.5.7 Validity:** A thorough review of the entire questionnaire was carried out on the entire questionnaire by senior researcher to ascertain its validity.

### **3.6 Statistical Analysis**

Data were analyzed using SPSS (IBM) Statistics version 26.0 software. Results are presented as percentage. Categorical variables were tested using Chi-square. Statistical significance was set at  $p < 0.05$ .

## **CHAPTER FOUR RESULT**

Table 4.1 show the socio-demographic factors of study participants. It was observed that

<b>Table 4.1 Socio- demographic factors of Study Participants</b>					
<b>Age(years)</b>	<b>Frequency</b>	<b>Percent</b>	<b>Chi-square</b>	<b>p-value</b>	
20.00-30.00	119	78.3	60.68	.001	
40.00-50.00	33	21.7			
<b>Sex</b>					
Males	74	48.7	.105	.746	
Females	78	51.3			
<b>Marital Status</b>					
Single	65	42.8	77.78	.001	
Married	86	56.6			
Widowed	1	0.7			
<b>Education Status</b>					
Tertiary	152	100.0			
<b>Occupation Status</b>					
Doctors	33	21.7	49.71	.001	
Medical Lab.Scientists	30	19.7			
Nurses	39	25.7			
Pharmacists	23	15.1			
Logistic Staff	12	7.9			
Administrators	14	9.2			
EMS Staff	1	.7			
<b>Religion</b>					
Christian	137	90.1	97.9	.001	
Islamic	15	9.9			
<b>How long have you work in current Hospital</b>					
5years	6	3.9	104.7	.001	
<5years	39	25.7			
>5years	107	70.4			
<b>Ethnicity</b>					
Bini	50	32.9	193.8	.001	
Hausa	5	3.3			
Yoruba	27	17.8			
Ibo	34	22.4			
Ijaw	9	5.9			
Esan	16	10.5			
Urobho	2	1.3			
Etsako	3	2.0			
Anang	1	0.7			
Idoma	4	2.6			
Other	1	0.7			

78.3%(119) were between the age of 20-30years, 21.7%(33) were between the age of 40-50years, 48.7%(74) were males, 51.3%(78) were females, 42.8%(65) were singles, 56.6%(86) were married, 0.7%(1) was widowed,100%(152) had tertiary education, 21.7%(33) were doctors, 19.7%(30) were medical laboratory scientists, 25.7%(39) were nurses, 15.1%(23) were pharmacists,7.9%(12) were logistic staff, 9.2%(14) were administrators, 0.7%(1) was EMF staff, 90.1%(137) were Christians, 9.9%(15) were Islams, 3.9%(6) had worked for 5years, 25.7%(39) had worked for <5years, 70.4%(107) had worked for >5years, 32.9%(50) were from Bini, 17.8%(27) were from Yoruba, 22.4%(34) were from Ibo, 10.5%(16) were from Esan, 5.9%(9) were from Ijaw, 2.6%(4) were from Idoma, 2%(3) were from Etsako, 3.3%(5) were from Hausa, 1.3%(2) were from Urobho, 0.7%(1) were from Anang and others tribe respectively.

**Table 4.2 Assessment of Awareness, Knowledge and Perception of Use of Drone in Healthcare Facility in Benin City**

Have you ever heard of drone being used in healthcare				
	Frequency	Percent	Chi-square	p-value
Yes	99	65.1	13.92	0.001
No	53	34.9		
Have you ever heard of drone being used to deliver medical supplies				
Yes	100	65.8	15.16	0.001
No	52	34.2		
Have you been to a place where drone are used for healthcare delivery				
YES	15	9.9	97.72	0.001
NO	137	90.1		
Can drones be used to deliver medical supplies to rural area				
Yes	111	73.0	109.43	0.001
No	14	9.2		
I don't know	27	17.8		
Where are drones typically operated from in healthcare settings				
Wards	110	72.4	30.42	0.001
Stores	42	27.6		
Do you think drones can improve medical supplies delivery in your hospital				
Yes	142	93.4	247.42	0.001
No	3	2.0		
I don't now	7	4.6		
Have you ever seen a drone in use at your hospital or nearby area				
Yes	13	8.6	104.45	0.001
No	139	91.4		
How willing are you to receive training in drone technology				
Highly willing	81	53.3	34.43	0.001
Somewhat willing	49	32.2		
Not willing	22	14.5		
Is there any department in your hospital that uses drone for medical purposes				
Yes	1	0.7	148.03	0.001
No	151	99.3		
Have you involved in any drone related medical delivery or training				
Yes	8	5.3	121.68	0.001
No	144	94.7		
If your hospital uses drone what medical supplies are delivered				
No response	150	98.7	144.11	0.001
Vaccine	2	1.3		
Can drone operations be affected by weather conditions				

Yes	110	72.4	104.22	0.001
No	21	13.8		
I don't know	21	13.8		
<hr/>				
If yes by what means are drones affected				
Wind	15	9.9	299.42	0.001
Wind and rain	130	85.5		
Rain and fog	5	3.3		
Rain,wind and fog	2	1.3		
<hr/>				
What is the full meaning of UAV (Unmanned aerial vechicle) in the context of drone				
I know	61	40.1	82.51	0.001
I don't know	91	59.8		

Table 4.2 show the assessment of awareness, knowledge and perception of use of drone in healthcare facility in Benin City. It was observed that 65.1%(99) heard of drone being used in healthcare while 34.9%(53) had not heard of drone being used in healthcare, 65.6%(100) had heard that drones are used to deliver medical supplies,34.2%(52) had not heard that drones are used to deliver medical supplies, 9.9%(15) had been to place where drones are used for healthcare delivery,90.1%(137) had not been to place where drones are used for healthcare delivery, 73.0%(111) had the perception that drone can deliver medical supplies to rural area,9.2%(14) had no perception that drone can deliver medical supplies to rural area, 17.8%(27) had uncertainty whether drone can deliver supplies to rural area, 72.4%(110) belief drones are operated from wards and 27.6%(42) belief drones are operated from stores,93.4%(142) belief that drones can improve medical supplies delivery, 2.0%(3) had no belief that drones can improve medical supplies delivery, 4.6%(7) had uncertainty whether drone could improve medical supplies delivery, 8.6%(13) had seen drone been used in hospitals, 91.4%(139) had not seen drone been used in hospitals, 53.3%(81) had high willingness to received training in drone technology, 32.2%(49) show level of interest to be trained but 14.5%(22) had no interest in drone technology training,0.7%(1) had knowledge of department that uses drone in hospital while 99.3%(151) had no knowledge of department that uses drone in hospital,5.3%(8) had be involved in drone training, 94.7%(144) had not be involved in drone training, 1.3%(2) belief that drone can be uses to supply vaccine, 72.4%(110) belief that drone operation can be affected by weather,13.8%(21) don't belief that drone operation can be affected by weather and 13.8%(21) had uncertainty if drone can be affected by weather,85.5%(130) belief wind and rain can affect drone, 9.9%(15) belief wind can affect drone, 4.6%(7) belief that rain, wind and fog can disrupt the operation of drones, 40.1%(61) know the full meaning of UAV(unmanned aerial vechicle) in

drone context while 59.8%(91) don't know the full meaning of UAV(unmanned aerial vechicle)  
in drone context.

## CHAPTER FIVE

### 5.1 DISCUSSION, CONCLUSION AND RECOMMENDATION

We are in a digital age where technology is improving; a drone is one aspect of this technology that is yet to be embraced in the health sector. Drone technology can help the health industry improve care delivery and safety with regards to rapid delivery of vaccines, medications and other health supplies to areas where they are needed in time preventing an outburst of deadly communicable illnesses (Oigbochie *et al.*, 2021). This study examined the knowledge and awareness of drone technology in healthcare among hospital staff in Benin City. The findings reveal important insights into awareness, knowledge gaps, perceptions, and attitudes toward drone technology. Although 65.1% of respondents had heard of drones being used in healthcare and 65.8% were aware of their use in delivering medical supplies, practical exposure remained very low, with only 9.9% of participants having visited a facility where drones were in use. This indicates that while conceptual awareness of drone technology exists, experiential knowledge and operational familiarity are lacking. These results are consistent with studies from both developed and developing nations. Claesson *et al.* (2016) demonstrated that although 55% of Swedish emergency staff were aware of drone technology, only 20% reported confidence in their operational knowledge due to limited training. Similarly, Jeyabalan *et al.* (2020) found that in India, less than 20% of healthcare professionals in rural regions had any practical knowledge of drone applications, despite being aware of their potential. In Nigeria, the GIZ-SEDIN (2023) report revealed that only 6% of healthcare workers spontaneously identified drones as an emerging healthcare technology. The low experiential exposure reported in the present study mirrors these global trends, underscoring a pressing need for structure education and hands-on training programs.

One of the most encouraging findings from this study is the high willingness to receive training. Over half of the respondents (53.3%) expressed strong interest in training, while an additional 32.2% indicated moderate willingness. This suggests that healthcare staff are receptive to adopting drone technology provided they receive the necessary knowledge and skills. This aligns with the findings of Hassanalian and Abdelkefi (2017), who emphasized that skepticism and resistance to drone adoption can be overcome with targeted awareness campaigns and practical demonstrations. Therefore, training and workshops could play a central role in bridging the gap between awareness and operational competency in Benin City.

Perception of the benefits of drones was also high in this study. An overwhelming 93.4% of participants believed drones could improve medical supply delivery, and 73.0% recognized their potential for rural healthcare delivery. These perceptions mirror successful case studies across Africa. For example, Zipline's drone network in Rwanda and Ghana has delivered millions of units of blood, vaccines, and medicines, reduced delivery times and improving maternal and child health outcomes (UNICEF, 2023; Zipline, 2025). These successes show that acceptance among healthcare workers in Benin City could translate into successful implementation if supported with the right infrastructure and regulatory framework.

Nevertheless, several barriers emerged from this study. A majority of participants (72.4%) acknowledged that drones are susceptible to weather disruptions, with wind and rain being the most cited factors. This aligns with Qureshi *et al.* (2021), who highlighted those technical vulnerabilities, such as limited payload capacity, short battery life, and weather sensitivity, remain significant obstacles to drone adoption in healthcare. In Nigeria, heavy rainfall, high humidity, and unstable power infrastructure may further exacerbate these technical challenges.

Thus, investment in weather-resilient drones and adaptive technologies is essential for sustainability.

Another barrier identified was the lack of operational presence of drones in healthcare facilities. Nearly all respondents (99.3%) reported that their hospitals did not have any departments utilizing drones, and 94.7% had never been involved in drone-related training or operations. This institutional absence indicates systemic barriers such as policy gaps, lack of government or private sector investment, and weak regulatory frameworks. Scott and Scott (2017) argued that without robust policies supporting drone deployment in healthcare, even the most advanced technologies cannot be fully integrated. Nigeria's regulatory environment currently restricts beyond-visual-line-of-sight operations, which are crucial for medical delivery drones (AFA, 2016). Therefore, reforms in aviation and health policy are necessary to enable real-world drone applications in Benin City and beyond.

This study also highlights misconceptions and knowledge gaps. A substantial proportion of participants (59.8%) did not know the meaning of UAV, revealing a fundamental lack of technical literacy. Misconceptions about drones—often linked to surveillance or military use—have also been documented in prior studies (Hassanalian and Abdelkefi, 2017). Such misconceptions can impede acceptance unless deliberate educational efforts are made. Public engagement campaigns that emphasize the humanitarian and medical benefits of drones could therefore be instrumental in shifting attitudes.

The socio-demographic characteristics of the participants also provide valuable insights. The dominance of young professionals (78.3% aged 20–30 years) suggests a workforce that is adaptable and open to innovation, yet their lack of experience (25.7% had less than 5 years in

service) may partly explain the limited practical exposure to emerging technologies. This highlights the importance of integrating drone education into medical and paramedical curricula, ensuring that future generations of healthcare workers are better prepared for technological innovations.

Overall, the findings underscore both challenges and opportunities. Moderate awareness and strong willingness to learn provide a fertile ground for policy makers, healthcare leaders, and technology providers to introduce pilot programs in Benin City. By addressing technical, regulatory, and cultural barriers, and drawing lessons from Rwanda and Ghana, Nigeria can harness drone technology to strengthen its healthcare delivery systems. This study contributes to ongoing debates about the feasibility of drones in low- and middle-income countries, providing local empirical evidence to guide future interventions.

## **5.2 CONCLUSION**

The study concludes that hospital staff in Benin City demonstrate moderate awareness but limited knowledge of drone applications in healthcare. While most participants recognize drones' potential to improve medical supply delivery, exposure to real-life drone operations remains very low. Encouragingly, there is strong willingness among staff to receive training, indicating a readiness to embrace drone technology in healthcare. Bridging the knowledge gap through training, policy integration, and pilot projects could accelerate the adoption of drones in Nigeria's healthcare system. Drone usability is on the rise as it offers a variety of exciting opportunities. Delivery of medical and laboratory supplies, blood products, including biopsy for emergency surgeries is just the starting point (Oigbochie *et al.*, 2021). Drones have the capability to evolve medical care as well as propel advancement to the health industry.

### **5.3 RECOMMENDATIONS**

1. Policymakers and healthcare institutions should organize training programs to enhance staff knowledge of drone operations and benefits.
2. Pilot projects should be implemented in Benin City hospitals to demonstrate practical applications and build confidence.
3. Awareness campaigns should be conducted to address misconceptions linking drones with surveillance or military use.
4. Investment in weather-resilient drone technology is necessary to ensure reliable operations in Nigeria's climate.
5. Government and private sector collaboration should be strengthened to develop supportive policies and infrastructure for drone healthcare delivery.
6. Further research should explore cost-effectiveness and sustainability of integrating drones into Nigeria's healthcare supply chain.

### **5.4 CONTRIBUTION TO BODY OF KNOWLEDGE**

This study contributes to the growing body of knowledge on drone technology in healthcare by providing empirical evidence on awareness, knowledge, and perceptions among hospital staff in Benin City, Nigeria. It highlights the moderate awareness but limited operational knowledge of drones, while underscoring the strong willingness for training and adoption. These insights can inform policy design, training interventions, and implementation strategies to facilitate drone adoption in Nigerian healthcare. The findings also add to comparative literature, demonstrating parallels with studies in other developing countries where awareness is low but acceptance potential is high.

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