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PROSPECTS FOR USING UNMANNED AERIAL VEHICLES FOR MEDICAL AND BIOLOGICAL PROTECTION OF THE CIVILIANS AND THE MILITARY IN THE SAFE ZONE AND THE JOINT FORCES OPERATION (JFO) AREA

Introduction. *In the 21st century, wars became revolutionary in terms of military affairs, as a result of the use of high-precision weapons, the large-scale application of various advanced information and analytical technologies, troop and weapon control systems, and the transition to noncontact combat operations, which have led to an increase in combat power due to the formation and the use of a single information and communication space in the combat zone.*

Problem Statement. *The use of unmanned aerial vehicles (hereinafter UAVs) for remedying the medical and social consequences of threats and improving the organization and provision of medical care to the civilians and the military is a relevant problem.*

Purpose. *The purpose of this research is to assess the prospects for the use of unmanned aerial vehicles for medical reconnaissance and emergency assistance to the civilians and the military.*

Material and Methods. *The publications in open sources of information have been analyzed with the use of a systematic approach, in accordance with the relevant instructions and rules of the State Regulation of Activities Involving the Use of the Airspace of Ukraine.*

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Results. *The advantages of using UAVs for medical reconnaissance and provision of emergency medical aid to victims in the safety zone and the JFO area, with the application of telemedicine elements have been established. The prospects for the development of unmanned aviation for the purpose of its use for remedial works to eliminate the consequences of emergency situations have been assessed and substantiated. The capabilities of UAV equipment to receive information in real time with lower economic costs as compared with manned aviation forces and means have been identified. These capabilities provide additional advantages of the use of UAVs in epidemiological studies.*

Conclusions. *The implementation of UAVs while organizing the provision of emergency medical care in Ukraine will significantly improve the timeliness, availability and completeness of its provision, increase the survival of the wounded and sick people in combat zones and hard-to-reach places, bring them closer to the European and world standards.*

Keywords: unmanned aerial vehicles (UAVs), medical protection of the civilians and the military, and Joint Forces Operation (JFO).

In the 21st century, the wars involving various groups of the NATO armed forces became revolutionary in terms of warfare, as a result of the appearance and use of high-precision weapons, advanced information technologies, the large-scale integrated employment of various information and analytical systems, troop and weapon control systems, as well as the transition to noncontact combat operations conducted by combined groups of troops, which have led to an increase in the combat power of the troops when they perform various combat tasks, including specific ones, due to the formation and use of a single information and communication space in the combat zone [1, 2].

Prospects for the use of unmanned aerial vehicles (UAVs), or drones, as they have been better known, are one of the most widely discussed topics in modern warfare. Among the unconditional advantages of UAVs there is the accuracy of aiming, which allows waging wars practically without risks to the lives of military personnel and with much smaller losses among civilians [3].

UAVs have been used since the Cold War, but at the beginning of the 1990s, only few countries had a technology to manufacture UAVs of the first generation [4]. In 2000, UAVs were used by the armed forces of 17 countries. By 2016, the number of these countries had increased to 90. Hence, it has been concluded that in the near future almost all world countries will have UAVs in service [5].

Military specialists of the advanced economies believe that in the modern combat environment, reconnaissance unmanned aerial vehicles may solve the task of aerial reconnaissance more effectively and efficiently, as compared with piloted reconnaissance aircraft. The time to bring the received intelligence information to the relevant decision-maker is reduced. Therefore, the Armed Forces of Ukraine need to be equipped with modern reconnaissance UAVs. While developing domestic reconnaissance UAVs, the designers have to take into account the world trends in the use of forces and means of unmanned reconnaissance vehicles.

The most characteristic feature of modern combat actions is the integrated process of intelligence, data transfer, control of troops and weapons, fire and radio-electronic suppression of the enemy on a time scale close to the real one. This allows minimizing the loss of military personnel and solving combat tasks more effectively. The results of the analysis of local wars and armed conflicts of our time have shown the growing role of unmanned aerial vehicles in solving aerial reconnaissance tasks [2].

For eight years, a hybrid war has been going on in the east of our country. It has taken the lives of more than 12,000 citizens of Ukraine and made more than 32,000 defenders and peaceful citizens disabled. Despite the Minsk agreements, the armed conflict in the East of Ukraine is accompanied by significant human casualties and causes enormous material, financial, social, and psychological damage to our state and citizens. It has highlighted a number of serious problems in the organization of emergency medical care at all stages of medical evacuation and determined the need for a detailed analysis of these problems and measures to overcome them.

From the first days of the anti-terrorist operation (ATO)/JFO in the East of Ukraine, several problems arose in the process of organizing medical support for the troops and the civilians living in the combat zone and safety zones. A low level of staffing the military medical service with personnel and medical personnel of the healthcare system, a lack of stocks of medical implements and medical products, UAVs for medical reconnaissance and telemedicine, armored means of evacuating the wounded from the battlefield, and inconsistency and lack of interaction between the military medical service and the civilian health care system were typical problems at the beginning of this war.

All this requires urgent measures to optimize the operation of the state healthcare system and the organization of interaction with the armed forces in combat conditions and with all ministries and agencies involved in the armed conflict [6].

Therefore, it is very important to analyze the experience of the use of UAVs by NATO members in order to determine the direction of the employment of these devices in JFO.

The impetus for the development of unmanned aviation in the world was the successful and widespread use of UAVs by the U.S. and Israeli armies during operations in the Persian Gulf, Yugoslavia, and in the Arab-Israeli conflict. Nowadays, there has been an upswing in the development of UAVs.

An unmanned aerial vehicle is an aircraft whose flight is controlled remotely, with the help of a special control station located outside the aircraft, or an aircraft that flies autonomously according to appropriate program [7, 8].

In advanced foreign economies, medical UAVs are considered aerodynamic containers that are used to transport medicines and medical products, including those for primary and pre-medical aid and vaccines. Although the U.S. Federal Aviation Administration adopted the term “unmanned aerial vehicle/system (UAV/UAS)” as early as in 2005, the term “drone’ has been still more preferred in the peer-reviewed medical literature [9].

Until now, UAVs have been mainly used in the military sphere. At the same time, as the analysis of the literature has shown, UAVs may be effectively employed to deliver blood, vaccines, drugs, organs, medical supplies and life-saving equipment [9].

In particular, various programs on the use of UAVs for the transportation of medical materials [10] have been initiated in Switzerland, the USA, the Netherlands, Bhutan, Papua New Guinea, Tanzania, Rwanda, Ghana, Malawi, and Haiti, with the support of UNICEF, Médecins Sans Frontières (MSF) or the World Health Organization (WHO). These drones have a carrying capacity of up to 2 kg, operate autonomously about 30—40 minutes; at best, and may cover 10 km in 18 minutes.

The use of UAVs has become particularly widespread in the EU countries, where their capabilities are actively employed for medical purposes. So, for example, in Germany, drones are used to deliver defibrillators. The *Deficopter* UAV may increase the chance of saving people during an emergency and in hard-to-reach places for ambulances. Having arrived at the victim, an UAV drops the defibrillator that can be used by people who are near the victim, without waiting for the arrival of ambulance. One such UAV is able to quickly deliver a defibrillator to a patient within a radius of 1.2 km^2, which increases the chance of saving a person from 8% to 80% [11]. It is known that every minute of delay in the use of a defibrillator reduces the chances of the victim’s survival by 7—10% [11].

In Poland, the *AtraxM* UAV was developed for medical purposes, equipped with interchangeable trays for transporting the first aid kits containing basic dressing materials; rescue kits for recovery after shock; medicines prepared given the patient’s need for immediate administration (for example, ampoules with adrenaline and insulin), provided that there is information about the symptoms and the need for an urgent response; medicines for people living in disaster-affected areas and blood bags.

The medical/biological reconnaissance in the area of JFO is particularly relevant. Thanks to video cameras built into medical UAVs, it is possible to carry out medical/biological reconnaissance and, with the help of telemedicine elements, to obtain informative and important images that help to understand the situation on the site, to allow the specialists to make an adequate decision that most effectively contributes to the determination of further actions for the provision of medical aid to harmed or injured people.

The ability of UAVs to obtain temporal and visual information in real time with a high resolution at a low cost makes them suitable for epidemiological studies. Such studies have been conducted in Malaysia, with the aim of monitoring populations of the malaria pathogen *Plasmodium knowlesi*, the spread of which is associated with changes in land use, as the deforestation and cultivation of agricultural crops have led to the fragmentation of the habitats of primate species that are the hosts of the malaria plasmodium [12]. Another thematic study with the use of UAVs has been conducted in the south of Spain, for monitoring the spatial distribution of large mammals carrying the tuberculosis pathogen *Mycobacterium tuberculosis* [13]. Recently, researchers have used medical drones with nucleic acid analysis modules to detect *Staphylococcus aureus* and Ebola virus [14].

Rapid delivery of vaccines, medicines, and medical products directly to the source of infectious diseases can ensure timely and high-quality measures to prevent the occurrence and spread of outbreaks of life-threatening infectious diseases [15].

The previous studies have demonstrated the possibility of delivering an Automated External Defibrillator (AED) with the help of drones to reduce response time in out-of-hospital cardiac arrest [16, 17].

Claesson et al. [17] have found a significant reduction in the response time in the case of AED delivery by drone during simulated cardiac arrest in locations with physical barriers (e.g., fjords) to EMS. However, as the authors have noted, research on the advantages of using drones in emergency situations is based mainly on the use of theoretical models, while the actual evidence on the use of drones has been quite limited [17].

Considering the prospects for the development of the use of unmanned aircraft for improving the availability and timeliness of emergency medical aid to the population and military personnel in the area of JFO, we assume that the growth of the medical UAV market will be facilitated by new technologies capable of increasing the efficiency and frequency of their use for emergency cases.

In the world, there has been reported a trend of investing in research and development for the creation of advanced UAVs for medical purposes [1—5, 10, 11]. Therefore, it is necessary to determine the advantages and disadvantages of their introduction into the daily activities of troops (Table 1).

The use of UAVs in practical activities related to eliminating the medical and biological consequences of military actions is one of the most effective means for conducting reconnaissance in the JFO area. Given the conditions of hostilities, the absence of an onboard pilot also enables improving the safety of personnel involved in such operations.

Since the beginning of hostilities in the East of Ukraine, more than 30 UAV models have been tested. In addition to reconnaissance, they are used to adjust/correct artillery fire and to evaluate fire strike impact. The Special Operations Forces have shown a great interest in the use of UAVs [15].

Currently, different types and models of UAVs have been employed to perform aerial reconnaissance missions in the JFO area, depending on the tasks and units: the aircraft-type UAVs (for example, *Leleka*-100 and *Furia*) [18, 19] and the multicopters (depending on the unit, different models with similar characteristics are used, for example, *DJI Phantom* modification).

Each type of UAV has its advantages and disadvantages and can be most effectively used depending on the tasks. So, let us consider the main features of different types of UAVs.

Thus, multicopter UAVs are the most common in various spheres of life, first of all, because of their lower cost. In terms of design and flight aerodynamics, they are most similar to helicopters with two main rotors (the coaxial scheme). Accordingly, they have the same advantages, namely:

Table 1. **Advantages and Disadvantages of UAVs**

Useful properties of UAVs	Advantages	Disadvantages
Mobility	Small dimensions and simple design allow UAV to be quickly deployed and used in the conditions of safety zone and JFO area. If necessary, it can be quickly delivered to the required area.	As a rule, small-sized UAVs used in the civil sphere, in particular for medical purposes, have a short flight range, which affects the effective radius of action.
Operability	The simplicity of the design, as compared with the classic aircraft, makes it possible to quickly put the UAV into operation and to deliver a cargo in the shortest possible time, without spending extra time on pre-flight works.	The average speed of UAV is significantly lower than that of manned aircraft. This factor can play a key role in the efficiency of delivery for distances close to UAV's maximum range.
Payload	Simple engineering solutions and low weight of the fastening elements allow quickly fixing a cargo without complicated procedures for its arrangement and mounting.	Low maximum payload puts significant restrictions on the amount of cargo that can be delivered or the equipment required to complete the tasks.
Weather conditions	Remote control allows the use of UAVs without restrictions on the weather minimums necessary for takeoff and landing (visibility and lower clouds).	At the same time, there are restrictions on the speed of oncoming and side winds, dangerous weather phenomena, precipitation, icing and other meteorological phenomena, which under certain conditions make the flight of UAVs impossible or impractical.
Operation in limited space	Small dimensions and high maneuverability allow the use of UAVs in limited space, difficult terrain (mountains, forests, etc.), and in densely populated areas of cities.	The use under such conditions, for safety reasons, is possible only if its flight is visually tracked and controlled. This means that UAV shall be piloted by operator in real time and be in the visibility zone.
Remote control	Remote control allows UAVs to be used in the most dangerous conditions for flight, where the use of manned aircraft is impossible due to an unacceptable risk, while the life and health of external UAV pilot is not threatened. This allows the use of UAVs in conditions of a critically unfavorable external environment, such as radiation or chemical pollution.	The communication channels used by most UAVs can be vulnerable to radio interference, adverse environmental conditions, weather conditions, obstacles, and terrain. A strong radiation background can also seriously complicate the operation of electronics. Reliable communication channels are required. The main systems of UAVs shall be protected against radio interference and environmental influences. A reliable system of UAV autonomous operation is required in case of loss of communication with pilot or loss of navigation signal.
Ease of control	Controlling UAVs does not require such special skills and knowledge as piloting a helicopter or an airplane. The training of an external pilot takes much less time and does not require such a demanding selection as in the case of manned vehicle pilots.	The ease of control and the absence of a "real threat" to the life of external pilot can encourage reckless actions and pose a threat to flight safety. UAVs have not been integrated into the general system of flight safety control and air navigation so far.
Low cost of use	Most UAVs do not require significant resources for operation. The cost of their use is much lower as compared with conventional aviation. This is why it has been widely used in various fields around the world.	Despite a high cost of use and maintenance, the capabilities of modern aviation technology far outweigh the capabilities of UAVs. In emergency situations, the use of manned aircraft can be much more reliable and provide the necessary operational efficiency.

- vertical take-off and landing, which makes it possible to direct the UAV and to carry out landing/take-off from any place;
- high maneuverability, the possibility of hovering in the air, moving backwards and forwards or being inclined towards any direction allow arriving at hard-to-reach places, staying there for a certain time, and even delivering a load that can be attached to the UAV suspension.

At the same time, they have disadvantages typical for this type of airborne vehicles, namely a lower engine efficiency that results in higher energy consumption and shorter flight time as compared with aircraft-type UAV engines. The same concerns certain aerodynamic properties.

The aircraft-type UAVs have the same aerodynamic design as conventional manned aircraft. They have significantly less capabilities in terms of maneuverability, mobility and, as a result, a narrower range of application. However, at the same time, they have several advantages they inherit from the “elder brother”, such as high speed, flight altitude, flight range, and radius of action. Also, their design/configuration allows a significant increase in the efficiency of the engines, which makes it possible to increase the take-off weight for installing more advanced avionics and increasing the quantity and quality of the payload. As a rule, UAVs of this type provide more opportunities for long-term observation and various types of reconnaissance, such as chemical and radiological.

So, each type of UAV has its own advantages and disadvantages. Therefore, it is necessary to choose an UAV depending on the task: the type of terrain, the weather conditions, the height of obstacles, the distance, or the area of the terrain that needs to be surveyed, the equipment that is needed, the need to operate in line-of-sight mode, or not, etc.

Flights in the conditions of hostilities in the JFO area or in the safety zone impose additional requirements that influence the choice of one or another UAV, regardless of their design features. While controlling such flights, personnel are usually in the most difficult, combat conditions, where the time to complete the task is limited. In this case, the key role is played by additional capabilities of the UAV or the complex, which affect the performance of tasks. The high quality of the control channels and the long range of communication and data transmission in real time allow the personnel to operate at maximum distance from the UAV flight area, which is very important in terms of workplace safety in the conditions of JFO.

One of the effective means of combating the UAVs is radio-electronic warfare equipment that may not only cover a combat zone, but also reach safety zones. Therefore, it is necessary to take into account that in the area of operation of such equipment, both control and data transmission channels shall be properly secured. The possibility of autonomous flight along a given route in radio silence mode can also be a useful option when there is no need for urgent online data transfer.

Therefore, when planning missions with the use of UAVs in the JFO area and the safety zone, it is necessary to take into account not only the specifications (Table 2) and capabilities of various UAVs, which are relevant for operation in normal “civil conditions,” but also the additional capabilities (Table 3) that ensure the efficiency and safety of flights and personnel in combat conditions in the JFO area and the safety zone.

Such experience should be extended to the provision of medical products and services to the troops. In particular, the capabilities of modern UAVs can be used in the framework of medical reconnaissance, aeromedical evacuation of the wounded, and telemedicine.

Since medical reconnaissance is primarily data collection, it is advisable to use UAVs to determine medical threats that can be detected from the air.

Modern equipment that can be installed on UAVs allows assessing the situation and risk factors of natural, climatic, ecological, socio-economic, and medical nature, which can affect the health of the personnel and the sanitary conditions of the troops, as well as the effectiveness of the medical service.

In our opinion, it is advisable to use UAVs for conducting such types of medical reconnaissance as medical and tactical, bacteriological, chemical, and radiation, as well as for identifying potentially dangerous objects that can affect the safety of troops.

In each case, the advantages of a certain type of UAV and the possibility of installing the necessary equipment on it should be taken into account.

As part of medical and tactical reconnaissance, UAVs can easily and quickly obtain information about the characteristics of the terrain, natural and socio-economic conditions, the state of the infrastructure, and other information that is important for the organization of medical support for the troops. Standard photo/video equipment is suitable for collecting such data. It is standard equipment of all UAVs and allows obtaining high-quality images, including real-time ones, which affects the efficiency of processing such data. Depending on the situation, it is advisable to use aircraft-type UAVs where it is necessary to survey large areas, or where the area is located at a considerably far distance. Copter-type UAVs are a good choice for short-distance flights, and given their mobility, high maneuverability, and the ability to hover in the air, they enable detailed study of individual sections of a large area. Both types of UAVs can be used simultaneously as part of complex.

As part of bacteriological reconnaissance, UAV reconnaissance equipment can be used to collect the necessary data that help to timely detect the enemy's preparation for the use of bacteriological weapons, or a terrorist act of a biological nature.

Table 2. **Basic Specifications of Various UAVs**

Specification	Leleka 100	Furia	DJI Phantom
Flight range	100 km	200 km	Up to 30 km
Range of operation	Up to 30 km	Up to 50 km	Up to 3 km
Flight duration	2.5 h	Up to 3 h	Up to 30 min
Speed:			
Maximum	120 km/h	130 km/h	60 km/h
Cruise	60—70 km/h	65 km/h	40 km/h
Flight altitude	1500 m		6000 m
Wind resistance	20 m/s	20 m/s	10 m/s
Temperature range	–20...+40	–20...+40	0...+40
Flight in unfavorable weather conditions	yes	yes	n/a
Payload	Modular, detachable	Modular, detachable	Modular, detachable
Takeoff	Catapult	Catapult	Vertical
Landing	Parachute	Parachute	Vertical

Table 3. **Additional Specifications of UAVs**

Specification	Leleka 100	Furia	DJI Phantom 4
Control channel	Up to 50 km	Up to 50 km	Up to 10 km
Data transmission channel	Up to 40 km		Up to 3.5 km
Channel security	Yes	Yes	No
Flight in the conditions of EW	Yes	Yes	No
Control modes	Manual and automatic	Manual and automatic	Manual and automatic
Navigation system	GPS	GPS, inertial	GPS
Additional load	Yes	Yes	n/a

In the framework of chemical reconnaissance, it is necessary to use additional equipment. Modern UAVs have the ability to install special sensors, gas analyzers for detecting dangerous chemicals. Flights over an area of probable contamination enable establishing the general characteristics of the environment and detecting the presence of dangerous chemicals.

As part of radiation reconnaissance, special sensors or dosimeters mounted on UAVs allow to remotely measuring the radiation background in a specific area without the presence of personnel there.

In the case of the use of bacteriological, chemical, or nuclear weapons by enemy, the UAV equipment provides an opportunity to register the very fact of the enemy committing similar actions or obvious intentions. Employing UAVs to take samples of soil, water, to detect dangerous chemicals in the air or a dangerous radiation background in certain areas of the terrain makes it possible to organize the collection and analysis of all data at a safe distance, without risks to personnel.

In addition to the actions of the enemy, there may be potentially dangerous objects in terms of explosion and fire, chemical, radiation and biological hazards.

The use of UAVs enables organizing constant monitoring of such objects and reducing the risks associated with emergency situations that may occur at such objects (Table 4).

Given the above, in our opinion, the use of UAVs for medical reconnaissance provides the following advantages:

- the capabilities of photo/video equipment and real-time data transmission allow constantly receiving data on changing conditions in the area of deployment and combat operations of troops, which ensures the continuity of medical reconnaissance;
- high operability of UAVs makes it possible to receive the necessary information at the right time, which ensures the timeliness and efficiency of conducting medical reconnaissance;
- the ability to work with data in real time while the UAV is still in the air over the required territory and the ability to adjust its flight to refine the data ensure the reliability of medical reconnaissance;

Table 4. **Medical Reconnaissance Tasks That May Be Fulfilled with the Help of UAVs**

Type of medical reconnaissance	Tasks for UAV	Required specifications
Medical and tactical reconnaissance	Collecting data on: ◆ environmental conditions ◆ infrastructure condition ◆ socio-economic conditions	Photo/video equipment; real-time data transmission
Bacteriological reconnaissance	◆ Collecting data on enemy's intentions; ◆ recording enemy's actions; ◆ taking soil and water samples	Photo/video equipment; real-time data transmission
Chemical reconnaissance	◆ Collecting data on enemy's intentions; ◆ recording enemy's actions; ◆ detecting dangerous chemicals ◆ monitoring chemically hazardous objects; ◆ taking soil and water samples	Photo/video equipment; real-time data transmission; equipment for the detection of dangerous chemicals
Radiation reconnaissance	◆ Collecting data on enemy's intentions; ◆ recording enemy's actions; ◆ detecting increased radiation background; ◆ monitoring radiation-hazardous objects ◆ taking soil and water samples	Photo/video equipment; real-time data transmission; equipment for the measurement of radiation background

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- high mobility of UAVs and the ability to combine them into complexes ensure medical reconnaissance in an active way.

A wide range of payloads for UAVs provides ample opportunities for their use within the framework of medical support for troops, in addition to reconnaissance. In particular, they may be employed for evacuating the wounded. Currently, various means are widely used in the army to pick up, to remove from a battlefield, and to evacuate the wounded. Aeromedical evacuation is considered the fastest way to evacuate the wounded. In this case, aid to the wounded is provided in a timely way. In order to successfully evacuate the wounded from battlefield, it is necessary to identify them in a timely manner. A thermal imaging camera mounted on an UAV and real-time data transmission make it possible to quickly identify places of concentration of people and centers of sanitary losses and to send the necessary forces and means for aeromedical evacuation there.

The growing capabilities of telecommunication technologies determine the development of such a direction as telemedicine.

Telemedicine is a field of medicine, namely a complex of actions, technologies, and measures used for the provision of medical aid, with the help of means of remote communication in the form of electronic message exchange (in cases where distance is a critical factor).

It is advisable to implement this direction to improve the medical support of the troops, as this way it becomes possible to provide quality care in a timely manner, regardless of the distance and without endangering medical specialists in the JFO area. In addition, telemedicine provides a number of other advantages:

- improving the results of providing medical care;
- increasing combat readiness;
- rationalizing the use of resources;
- postponement, and in some cases, avoidance of evacuation measures;
- the possibility of attracting a large number of specialists;
- reducing the burden on medical institutions and medical workers;
- reducing losses.

For telemedicine, it is necessary to ensure:

- duty staff;
- means of two-way communication;
- personnel training.

Since telemedicine depends on direct communication between doctor and patient and reliable data transmission, the use of UAVs can significantly increase the availability of such care. The mobility of drones, and therefore the ability to deliver the necessary communication capabilities to hard-to-reach places (or even to battlefield) makes telemedicine possible in combat conditions, in particular, in the JFO area. It is possible to increase the efficiency of this type of medical care through delivering a drone to the required location, not only as a means of communication, but also as a small container with the necessary medicines that the wounded person needs and uses them in accordance with a doctor's advice.

Therefore, the use of UAV capabilities in the provision of medical services to troops can be considered one of the full-fledged directions of the use of such means in the JFO area, which can not only significantly increase the efficiency of medical reconnaissance and speed of aeromedical evacuation of the wounded, but also, with the help of new approaches such as telemedicine, to significantly reduce losses among the wounded by bringing medical aid closer to them.

Today, UAVs are widely used by the Armed Forces of Ukraine in the JFO area. These vehicles have proven their effectiveness in reconnaissance to detect enemy forces, reconnaissance of the area, and artillery fire correction [19]. Drones are constantly used by special operations forces. Unmanned combat aerial vehicle complexes of various classes have been more and more widely introduced [15].

CONCLUSIONS

1. The world experience in the use of UAVs has shown that their use for liquidating the medical and biological consequences of emergency situa-

tions among the population and providing medical aid to the wounded and sick in safety zones and JFO area is indisputably important.

2. Given the advantages and disadvantages, it can be stated that the use of UAVs is necessary, and its use for the implementation of measures for medical and biological protection of the population provides many advantages, such as improving the provision of emergency (urgent) medical care due to a significant reduction in the time required to reach the patient, which, in turn, results in a decrease in the number and severity of complications for the harmed and wounded in combat zones and in hard-to-reach places. This factor brings the medical services closer to the European and world standards.

3. The ability of UAVs to obtain real-time temporal and visual information with a high resolution at a low cost makes them suitable for epidemiological studies.

4. As part of medical and tactical reconnaissance, UAVs can easily and quickly obtain information on the characteristics of the area, its natural and socio-economic conditions, the state of the infrastructure, and other information that is important for the organization of medical support for the troops.

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ПЕРСПЕКТИВИ ЗАСТОСУВАННЯ В МЕДИКО-БІОЛОГІЧНОМУ ЗАХИСТІ НАСЕЛЕННЯ І ВІЙСЬК БЕЗПІЛОТНИХ ЛІТАЛЬНИХ АПАРАТІВ В ЗОНАХ БЕЗПЕКИ ТА ОПЕРАЦІЇ ОБ'ЄДНАНИХ СИЛ

Вступ. Війни, що відбувались у XXI столітті, стали революційними у військовій справі завдяки появі та застосуванню високоточної зброї, широкомасштабному використанню різних новітніх інформаційних та аналітичних технологій, систем управління військами та зброєю, переходу до ведення безконтактних бойових дій, що призвело до збільшення бойової потужності за рахунок формування й використання єдиного інформаційно-комунікаційного простору в зоні ведення бойових дій.

Проблематика. Актуальною є проблема використання безпілотних літальних апаратів (БпЛА) для подолання медико-соціальних наслідків загроз, покращення організації та надання медичної допомоги населенню і військовослужбовцям.

Мета. Дослідити перспективи використання БпЛА для проведення медичної розвідки та надання екстреної допомоги населенню й особовому складу військ.

Матеріали й методи. Аналіз публікації було здійснено з використанням системного підходу згідно з відповідними інструкціями та правилами Державного регулювання діяльності в галузі використання повітряного простору України.

Результати. Встановлено переваги застосування БпЛА в процесі медичної розвідки та надання екстреної медичної допомоги постраждалим в зонах безпеки та проведення ООС з використанням елементів телемедицини. Обґрунтовано та визначено перспективи розвитку безпілотної авіації під час проведення робіт з ліквідації наслідків надзвичайних ситуацій. З'ясовано можливості апаратури БпЛА отримувати інформацію в режимі реального часу з меншими економічними затратами у порівнянні з пілотованими авіаційними силами та засобами, що надає додаткові переваги при їх застосуванні в епідеміологічних дослідженнях.

Висновки. Впровадження БпЛА в процес організації надання екстреної медичної допомоги в Україні суттєво покращить своєчасність, доступність та повноту обсягів її надання, підвищить виживання поранених і хворих у зонах ведення бойових дій та постраждалих у важкодоступних місцях, наблизить її до європейських та світових стандартів.

Ключові слова: безпілотні літальні апарати, медичний захист населення та військ, зони безпеки та ООС, медична розвідка.