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Effectiveness of Automated External Defibrillator Drones for Handling Out-Of-Hospital Cardiac Arrest (OHCA): Literature Review

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ABSTRACT

Background: Out-of-hospital cardiac arrest is one of the leading causes of death worldwide. Out-of-hospital cardiac arrest or OHCA represents a significant burden of disease globally. The number of out-of-hospital cardiac arrests reaches 360,000 events every year. Treatment for cardiac arrest requires immediate defibrillation to increase the survival rate of OHCA patients. One method that can be used is by sending Automated External Defibrillator Drone using drones. It is hoped that sending and using AEDs via drones can increase the rate of AED application and reduce defibrillation time.
Methods: This study is a literature review which that aims to determine the effectiveness of AED drones for treating out-of-hospital cardiac arrest (OHCA). This literature review analyzes 10 articles originating from journal databases, namely Google Scholar, Pubmed, and Science Direct with the keywords "Drone AED", "EMS". And “Out-Of-Hospital Cardiac Arrest”.
Results: The results of the analysis show that AEDs delivered with an Unnamed Aerial Vehicle (UAV) system using drones can reduce the time for administering defibrillation immediately before health workers arrive. Success in treating OHCA and a higher chance of life, as well as AED delivery by drone can also save costs. to send an EMS ambulance
Conclusion: Based on the results of the analysis of several articles, it was concluded that AED drones were effective in delivering AEDs in cases of Out-Of Hospital Cardiac Arrest (OHCA) which occurred in remote areas or far from public locations. AEDs delivered using an Unnamed Aerial Vehicle (UAV) system using drones can reduce the time to provide defibrillation immediately before health workers arrive, resulting in success in treating OHCA and a higher chance of life. AED delivery by drone can also save the costs required to send an EMS ambulance. However, there are several obstacles that can be found from several articles, namely that sending AEDs requires a flight permit from the government, the design of drones for AEDs must be appropriate, and in bad weather sending AEDs by drone can be hampered. Therefore, further research needs to be carried out to provide a solution for sending AED drones during extreme weather.

Keyword : Drone AED; EMS; Out-Of-Hospital Cardiac Arrest

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Background. Out-of-hospital cardiac arrest is one of the leading causes of death worldwide. Out-of-hospital cardiac arrest or OHCA imposes a significant burden of disease globally (Choi et al., 2021; MacKle et al., 2020). The number of out-of-hospital cardiac arrests reaches 360,000 events every year. Based on data from the Ministry of Health's Yankes, OHCA is 15% of the causes of death (Ministry of Health, 2022). Rapid out-of-hospital cardiac arrest treatment can increase the survival of OHCA patients (Mottlau *et al.*, 2022).

Treatment for out-of-hospital cardiac arrest or OHCA is currently provided with cardiopulmonary resuscitation (CPR) by lay individuals and only 2% use an automatic external defibrillator (AED) (Benson *et al.*, 2022). Based on the 2020 AHA recommendation, immediate defibrillation should be treated for cardiac arrest in order to increase the survival rate of OHCA patients. OHCA occurs quickly and surprisingly, the chances of survival are reduced by 10% every minute without defibrillation (Schierbeck et al.,

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2022). Currently, automatic external defibrillators (AED) are provided through the public access defibrillation (PAD) program in several public places (Tindale et al., 2021). Public access defibrillation (PAD) helps someone who sees a cardiac arrest to provide immediate defibrillation before medical personnel arrive, but the PAD program has limitations when the OHCA event occurs in a private home or not in a public place (Lim et al., 2022).

Optimizing the use of AEDs in PAD programs for treating cardiac arrest in private homes can be done by increasing delivery times and increasing AEDs at the location where OHCA occurs. One method that can be used is by sending AEDs using drones. Delivery and use of AEDs via drones is expected to increase the rate of AED application and reduce defibrillation time. (Lim et al., 2022 ; Tierney, 2022).

Drones are small aircraft that can be operated remotely without a human crew (Roberts *et al.*, 2023)The development of drone technology has increased its capabilities and expanded its use from the military field to other fields (Apiratwarakul *et al.*, 2022). The use of Unmanned Aerial Vehicles (UAVs) or drones to deliver life-saving medical devices as AEDs has become a growing area of interest over the past few years. (Schierbeck et al., 2022). Drones can help people helping OHCA patients to provide immediate defibrillation before medical personnel arrive and minimize the time the rescuer has to find the location of the PAD. Delivery of AEDs using drones is very helpful in handling OHCA during this period, but it is necessary to review the role of AED drones in OHCA events that occur in locations far from PAD access (Hanna *et al.*, 2024).

Based on the above phenomenon, the author wants to conduct a literature review regarding the effectiveness of AED drones in treating out-of-hospital cardiac arrest (OHCA). It is hoped that the results of this literature review can become a reference for evidence-based interventions that have been carried out. The aim of this literature review is to identify research articles related to the effectiveness of drone AEDs in treating out-of-hospital cardiac arrest (OHCA).

Methods. This literature review uses an article search method in electronic databases, namely Google Scholar, Pubmed and Science Direct, which produces 10 articles. The inclusion criteria used in this literature review were articles published from 2020-2022, full paper, unpaid, articles in English, with the keywords "Drone AED", "EMS" and "Out-of Hospital Cardiac Arrest".

Result and Discussion.

Table 1. Summary of Article Analysis

No	Author	Year	Methode	Sample	Result
1	Joseph Chun Liang Lim, et all	2022	*Systematic review*	26 article	Drone delivery of AEDs in a controlled environment is faster than EMS services, reducing defibrillation time and improving OHCA outcomes
2	Jessica K, et all	2020	Experimental Design	35 participants	The role of drones in AED delivery increases the use of AEDs for rescuers and improves outcomes in OHCA victims
3	Roper, Fischer, Baumgarten, Thies,Kamp, Flera.	2022	Experimental design	3930 km^2	Sending AEDs using the unnamed aerial system (UAS)/drone method can reduce defibrillation time and save costs in the event of OHCA
4	Sofia Schierbeck, et all	2021	Experimental design	14 Cases	Of the 14 cases suspected of having OHCA, 11 results were successfully achieved

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					using an AED drone
5	K. Sedig, M.B. Seaton I.R. Drennan, S.Cheskes K.N.Dainty	2020	Qualitative descriptive	67 participants	The use of AED drones is effective in treating OHCA in remote areas.
6	Jan Bauer, Dieter Moormann, Reinhard Stramet z, David A Gronebe rg	2021	Experimental design	3296 participants	OHCA assistance with AEDs delivered by unnamed Aerial vehicle network in the form of drones is more cost effective.
7	S. Schierbeck, et all	2021	Retrospective observation	39,246 participants	Delivery of AEDs using drones for handling OHCA takes <8 minutes so it can save time.
8	Clement Derkenne, et all	2021	Experimental design	3014 participants	In this study 26% of OHCA patients received AEDs before BLSt in a densely populated urban setting.
9	Maria I. Mermiri, Georgios A. Mavrovounis, Ioannis N. Pantazopoulos.	2020	*Literatur Review*	214 articles	Delivery of AEDs using drones at OHCA locations has shown very promising results.
10	Sheldon Cheskes, et all	2020	Experimental design	2 Rural	Delivery of AED drones to OHCA locations speeds up the response distance and time to reach OHCA locations

Search results from several articles that have been researched state that sending AEDs using drones to OHCA locations, especially in remote areas or far from public access, can help speed up response time and reduce fibrillation time to improve OHCA results. This is in accordance with Jesicca K et al's research on delivering AEDs via drone at simulated cardiac arrest locations. Jesicca's research states that several rescuers can continue to carry out cardiopulmonary resuscitation during AED delivery by drone (Zègre-Hemsey et al., 2020 ; Scholz et al., 2023). so that victims can continue to receive cardiopulmonary resuscitation and rescuers do not need to stop CPR when looking for a drone**.**

Jan Bauer's research in Germany also explains positive things about the use of AEDs delivered using unmanned aerial vehicles (UAV) in the form of drones, which can reduce costs calculated by financial ratios for additional needs compared to the EMS currently used (Bauer et al., 2021; Scholz et al., 2023). This is supported by Maria et al's research which states that delivering AEDs using certain types of drones can reduce delivery and defibrillation times compared to sending an EMS system so far (Mermiri et al., 2020). In Maria's research, she explained that there are several shortcomings in using drones, such as each country has its own policies regarding the use of drones, the need for drone operator experience and the cost of designing and modifying drones that can carry AEDs is still high (Mermiri et al., 2020; Derkenne et al., 2021)

Similar research conducted by Schierbeck using geographic analysis (GIS) found that sending AEDs using drones saved 8 minutes compared to ambulance response times to densely populated areas of OHCA patients (Schierbeck et al., 2021). The UK has a standard that treatment of OHCA patients must be given the first defibrillation in less than 8 minutes for the OHCA patient's chance of survival, while the ambulance can arrive in 15-20 minutes to the OHCA location. So delivering AEDs using drones can save time and increase the chances of survival in OHCA patients (Schierbeck et al., 2021; Tierney, 2022). The obstacle in the research conducted by Schierbeck is that the flight zone boundaries for unnamed aerial vehicles (UAV) in the form of drones need to be agreed with the government (Masuda et al.,. 2022).

Dong Sun Choi's research comparing the delivery of AEDs via UAV in the form of drones and EMS ambulances seen from the topography of the OHCA area states that if the weather is

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extreme, there are many tall buildings and densely populated areas at the OHCA location, the time required for the OHCA ambulance to provide the first defibrillation is around 10 minutes, whereas for The first defibrillation UAV-AED takes approximately 8 minutes (Choi et al., 2021).

Based on Dong Sun Choi's research, an EMS ambulance can be sent if the address of the OHCA to be addressed is detected, while the UAV-AED will be sent immediately when a cardiac arrest is detected. So the use of UAV-AED via drone can save AED delivery time and speed up the provision of first aid defibrillation to OHCA patients (Choi et al., 2021; Frigstad et al., 2023).

Nigel Ress' research using a beyond visual line-of-sight (BVLOS) system succeeded in delivering AEDs to OHCA patients in remote and rural locations that were difficult to reach by EMS ambulances, a distance of 4.5 km taking 2 minutes. However, Nigel Ress' research also explains that bad weather can affect the delivery of AEDs using BVLOS in the form of drones (Rees et al., 2021)

The limitation of this research is that researchers have not found much research on AED drones that further supports this research.

Conclusion and Suggestions

Based on the results of the analysis of several articles, it was concluded that AED drones were effective in delivering AEDs in cases of Out-Of Hospital Cardiac Arrest (OHCA) which occurred in remote areas or far from public locations.

AEDs delivered using an Unnamed Aerial Vehicle (UAV) system using drones can reduce the time to provide defibrillation immediately before health workers arrive, resulting in success in treating OHCA and a higher chance of life.

AED delivery by drone can also save the costs required to send an EMS ambulance. However, there are several obstacles that can be seen from several articles, namely that sending AEDs requires a flight permit from the government, the design of drones for AEDs must be appropriate, and in bad weather sending AEDs by drone can be hampered. Therefore, further research needs to be carried out to provide a solution for sending AED drones during extreme weather.

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