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Marek Siuta
Jegiellonian University Medical College
Faculty od Health Sciences
Department of Emergency Medicine
e-mail: marek.siuta@uj.edu.pl

A glider accident – emergency medical rescue action

SUMMARY

Introduction. This paper has been inspired by the analyses of paramedics' training programs, along with the observation of a glider accident simulation workshop organized by the author. Medical team members' knowledge specifically related to aviation accidents is insufficient.

Research problem and research method. Research was aimed at analyzing and synthesizing data about medical rescue action in case of glider accident. Research was theoretical and interdisciplinary. Knowledge in the field of soaring sport and medical rescue was structured and integrated. Analyses were based on specialist literature, aircraft technical data and author's personal experience as both paramedic and aviator. It concerned, among other aspects: flight and landing characteristics, glider equipment, mechanism of injury and undertaking rescue action.

Results. Various source data analyses and its further syntheses does structure and broaden knowledge about glider accidents. It has been proven on theoretical level, that there exists a relation between the knowledge of an aircraft and undertaking proper rescue action in case of an air crash.

Conclusions and summary. Data comprised in the article is of both cognitive and introductory character. It may support paramedics in individual development of professional qualifications. It may also serve as the base of medical team training program. Relations presented in the article may be empirically verified by further research.

Key words: soaring, glider, sailplane, aviation accident, emergency medical service.

Glider accident – emergency medical rescue action

Soaring is considered a safe sport, but there is always an accident risk. Paramedics in Poland are not familiarized with characteristics of rescue action in case of glider accident. The article describes potential glider accident process and mechanism of injury. This may broaden rescue team members' knowledge in the subject matter.

Soaring in Poland

Soaring is an aviation sport discipline, strongly connected with specific technological branch. In Poland soaring has long tradition, originating well before World War II. After the war Polish works were among the world's leading sailplane manufacturers. Between the year 1946 and the dusk of communist Polish People's Republic Szybowcowe Zakłady Doświadczalne (*Glider Expoerimental Works*) in Bielsko-Biała (formerly known as Instytut Szybownictwa – *Institute of Soaring*) designed nearly 60 glider types. This meant introducing new airframe almost once a year, for four decades. These gliders were widely used throughout Poland, and abroad[1]. Some types have been exported to as many as 40 countries, where many Polish gliders are still airworthy.

As for the end of 2018 there were 944 gliders and 32 motor-gliders in Polish registry[2]. At the beginning of 2018 in Poland 2883 individuals held the glider pilot's license – either the SPL or LAPL(S)[3], with 194 new licenses issued in 2018 by the Civil Aviation Authority. In the time period of 2008–2018 glider pilot's license keeps being issued on average for 163 pilots per year (with increasing rate – there were 127 licenses issued in 2008, and 218 in 2018)[4]. On early training level student-pilot is allowed to fly solo, supervised by the instructor from the ground. Therefore the total number of people allowed to fly gliders is higher than the number of valid licenses. Soaring may be treated as pilot training level on the way to achieving commercial or airline pilot's license. Aviators who choose this way frequently withdraw from flying gliders after being given the right to fly engine powered airplanes. There are still many pilots, who treat soaring as a form of recreation or competition.

There are many places in Poland, where sailplanes are flown. Most flights take place in close proximity of airfields and landing sites. In 2018 there were 40 aero club airfields[5]. Several facilities not being recognized as aero clubs are in use, such as: mountainous gliding site in Bezmiechowa (Góry Słonne mountains), Bobulandia site in Weremień (Bieszczady mountains) and former air force base in Biała Podlaska, now used by BB-Aero flight school.

Gliders are flown mainly between spring and autumn, with summer holidays being the best season for initial pilot training. Modern flying takes place virtually only in daylight. At night weather is not favorable for glider pilots, but properly equipped gliders are allowed to fly after sunset.

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[1] *Polskie szybowce 1945–2011. Problemy rozwoju*, red. A. Glass, T. Murawski, SCG, Bielsko-Biała 2012, s. 9.

[2] J. Liwiński, *Rejestr polskich statków powietrznych*, „Przegląd Lotniczy Aviation Revue" 2019, nr 294, s. 26–36.

[3] SPL – Sailplane Pilot License, LAPL(S) – Light Aircraft Pilot License (Sailplane).

[4] Urząd Lotnictwa Cywilnego, *Rejestr Personelu Lotniczego (2008–2018)*.

[5] Aeroklub Polski, *Wykaz klubów sportowych AP posiadających licencję klubu sportowego na rok 2018*.

Glider flight characteristics

Soaring sport is all about keeping powerless aircraft aloft. This is possible thanks to the existence or coexistence of three meteorological phenomena. The first, and most common one, are thermals. Uneven temperature of air masses leads to creation of areas, where warm air ascends faster than the surrounding cool air. Staying within such a thermal requires glider pilot to fly around its center – this maneuver is known as “thermaling”. Thermal soaring areas are few and far between, and staying within one is demanding. This frequently leads to several gliders thermaling within small area. Separation between them is little, flight takes place in uncontrolled airspace, and visibility from glider cockpit is limited. All these factors increase the risk of mid-air collision.

The second technique allowing for motor-less flight is ridge soaring. Wind hitting the mountain slope presses the air upwards, along with the glider. Such flight requires no thermaling – glider flies back and forth along the windward ridge. If several gliders fly along the same ridge, they need to pass each other in opposite directions, in close proximity. This increases collision risk, especially taking into account that it is hard to spot the aerodynamically slim glider when looking directly from the front or the back. Ridge soaring pilots are also prone to making a mistake of flying over leeward ridge. This is the area of strong wind rotors and gusts, easily capable of causing loss of control.

The third – most rare, but also the most spectacular weather phenomenon is the mountain wave. This requires certain combination of wind speed, direction, terrain shape and atmosphere stability level. Meteorological details are not important for the purpose of this article. It is worth noticing that wave soaring allows for reaching altitudes otherwise unattainable (up to over 10 kilometers/33000 feet), where pilot is exposed to hypoxia and hypothermia.

One of soaring disciplines aims at covering the longest distance possible. Sometimes pilot fails to reach declared cross-country destination. Failure to gain altitude while thermaling, or sudden weather change, calls for “outlanding” – landing in place other than airfield. Usually this is a large field or meadow. Gliders are designed for such landings, outlanding is also fully legal. It is neither an accident nor an incident, as long as nobody gets hurt and the glider stays undamaged. If no field for outlanding is available, glider may ditch – its structure makes it easy to stay afloat. Regardless of specific situation, glider pilot has always a single chance for touchdown. Glider can never go around in case of misconducted landing approach.

There are two main ways of launching the glider. The first is winch launch. Winch is connected to the glider by cable (usually 600–1000 meter/2000-3200 feet long). This allows for releasing the glider at 200–500 meters (650–1650 feet) above the ground level. Winch launch is a very dynamic procedure, therefore dangerous to a certain degree. Details about winch launch risk are described further, among accident causes. Winch can launch even a heavy a glider very quickly – in Polish Biała Podlaska airfield a twin-seat SZD-54-2 Perkoz glider reached 1852 meter (6076 feet) altitude in 144 seconds (this required a 4100 meter/13500 feet long cable)[6]. The alternative for winch launching is aerotow, during which glider is being towed aloft by airplane tug. This is safer, and allows for releasing the glider at any altitude, also at significant distance from takeoff point. Winch launch is more common, and significantly cheaper launch method.

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[6] Ośrodek Szkolenia Lotniczego *BB-Aero – sailplane flight logbook for 2.01.2016.*

Glider equipment

It is important for rescue team members to be familiar with glider elements important in terms of mechanism of injury and casualty extrication. Sailplanes are either single- or twin-seat airframes. There were few three-seaters with two of the seats side by side built, but such gliders are rare exotics. Standard twin-seat glider has seats in tandem layout, with front one for student-pilot and rear one for the instructor-pilot. If such a glider is flown solo, pilot occupies the front seat.

Modern gliders are made of composite materials. Earlier technology produced wooden airframes covered with plywood and canvas. Such gliders, for example training SZD-9bis Bocian or single-seat SZD-30 Pirat are still in wide use, in some cases 50 years after leaving production line. Metal gliders never entered production on scale comparable with wooden or composite craft.

It is important to get the idea of how fast and how heavy gliders are. Table 1 shows basic speed and weight data of widely used Polish glider types.

Table1. Airspeed and empty weight of various types of Polish sailplanes

Type	Category	Airspeed			Weight
		Stall	Optimum	Never exceed	
SZD-9bis Bocian 1E[1]	Twin-seat, wooden	60 km/h/37 mph	80 km/h/50 mph	200 km/h/124 mph	345 kg/761 lb
SZD-50-3 Puchacz[2]	Twin-seat, training, composite	58 km/h/36 mph	85 km/h/53 mph	215 km/h/134 mph	364 kg/802 lb
SZD-30 Pirat[3]	Single seat, training -performance, wooden	60 km/h/37 mph	75 km/h/47 mph	220 km/h/137 mph	255 kg/562 lb
SZD-51-1 Junior[4]	Single-seat, trai-ning, composite	55 km/h/34 mph	80 km/h/50 mph	220 km/h/137 mph	240 kg/529 lb
SZD-48-3 Jantar[5]	Single-seat, high -performance, composite	68 km/h/42 mph	95 km/h/59 mph	285 km/h/177 mph	274 kg/604 lb
SZD-48-3 Jantar[6] (with water)	Single-seat, high -performance, composite	82 km/h/51 mph	123 km/h/76 mph	285 km/h/177 mph	424 kg/935 lb

Legend:

Stall speed – airspeed below which wings do not create sufficient lift

Optimum speed – airspeed at which the glider has the greatest range

Never exceed speed – airspeed, above which there is a risk of airframe disintegration in mid-air

Source: own elaboration based on respective pilot's operating handbooks.

Notice the variation in data concerning the high-performance SZD-48-3 Jantar glider. This sailplane category features ballast compartments fitted into wings. Before takeoff they are filled with 150–200 liters (33–44 gallons) of water. This makes the glider heavier, and capable of reaching its destination at higher speed. Water ballast is dumped before landing.

Before high-altitude flight (expected altitude over 3000–4000 m/9800–13100 feet ASL) glider is equipped with oxygen installation. One or two oxygen cylinders are fitted behind the cockpit, close to the center of gravity. Reducer with regulator is within pilot's reach. Oxygen is delivered into face mask or nasal cannula. Oxygen used in aviation is dry (as opposed to medical oxygen) in order to reduce the risk of installation freeze. Pilot regulates oxygen flow on the basis of altitude tables and self-feeling. Pilots are trained in "Human factor in aviation" subject and are capable of recognizing early hypoxia symptoms. If these occur despite oxygen supplementation, it is advised to lower flight below the 3000 meter (9800 feet) ASL mark. Pilots preparing for high-altitude flight wear winter clothing, irrespective of the actual season. Glider cockpit is neither heated, nor pressurized, and surrounding temperature decreases by 0,6–1°C per 100 meter (33–33,8°F per 330 feet) altitude gain[7].

Glider seats are designed to fit parachutes, and pilots wear them for virtually every flight. Rescue parachute is easily removable, by unbuckling three points – one buckle on the chest, and one on each thigh. Pilot is secured in place by four- or five-point harness. Belly belts are tight, shoulder ones are slightly more loose. The harness is pulled tight while approaching outlanding, emergency landing or before an aerobatic flight. All harness types are released by single action. Older models required pulling a pin or loose belt to the side, modern ones have a knob to be rotated (to either side). Some gliders, especially rated for aerobatics, have straps on rudder pedals in order to hold feet in place during inverted flight.

It is fairly easy to reach the pilot. Cockpit is covered by plexiglass canopy, easy to release in an emergency by using two knobs inside the canopy – red and white or two red ones. There is also a canopy vent on the left side, large enough to reach the interior. If there is any difficulty getting the canopy released, it is easy to break. Breaking process should begin in the corner of the vent.

Hazardous materials

Sailplane without propulsion system carries no hazardous materials except for battery electrolyte and – in some cases – oxygen. Batteries are located behind the cockpit, close to the center of gravity. One battery is for powering the radio. If the glider has electronic avionics, the second battery is fitted. Some modern gliders have additional solar cells. During aerobatic displays pyrotechnic smoke generators are frequently fitted to the wingtips.

Few gliders (3,3% of registered in Poland[8]) are fitted with propulsion system – these are called motor-gliders. Motor can serve one of two purposes. The first is „full scale propulsion". It is usually a nose-mounted fixed engine with fairly large fuel tank. Along with modified landing gear, the glider is turned into airframe which can be used in a manner very similar to light airplane. Another solution is the "sustainer" engine. This engine is not for routine use, it is there to allow the glider reach its destination in case of no more conditions for soaring. It is therefore the alternative to an outlanding. Engine and propeller assembly should not impair aerodynamics, so it is retractable in a way similar to airliners' landing

[7] P. Dudek, Z. Włodarczyk, *Paralotniarstwo*, Arete, Bydgoszcz 2006, s. 44; K. Stewart, *Podręcznik pilota szybowcowego – praktyka. Szkolenie szybowcowe*, Pileus, Żółwin 2015, s. 28.

[8] J. Liwiński, *Rejestr polskich statków powietrznych*, „Przegląd Lotniczy Aviation Revue" 2019, nr 294, s. 26–36.

gear and hidden inside the fuselage. Sustainer engines are either simple internal combustion motors with small (about 10 liters/2,2 gallon) fuel tanks or much more reliable electric motors. Motor-glider is the only glider category carrying fuel, which means a risk of fire after crash.

Flight phase vs. accident risk

Polish Civil Aviation Authority (Urząd Lotnictwa Cywilnego) publishes annual civil aviation safety reports. European Aviation Safety Agency (EASA) publishes similar data for 32 member states. The most up-to-date Polish document available at the time of this article's publication is the report for 2017. It states, that in 2017 there were 12 glider accidents, with two fatalities (both during competitive soaring) and one serious casualty [9]. These figures correspond to data for 2007–2017 period, where average accident number per year is 18,4, with 2,0 fatalities and 2,4 serious casualties [10]. Most accidents occurred in 2015 (28), the fewest in 2012 and 2013 (16 in each year mentioned). EASA data shows, that the overall accident number per year keeps decreasing, but the average fatalities rate is constant [11].

EASA Annual Safety Review 2018 contains interesting information about fatal accident circumstances. The most common is collision with hill, followed by an incomplete winch launch and stall/spin [12].

Collision with hill may occur while mountain ridge soaring. Accident may take place at high speed, in remote area (also densely forested) and at low temperature. EASA indicated, that if collision with hill takes place, there is high risk of serious injuries.

Incomplete winch launch is also considered a high risk accident. During winch launch the glider ascends at high angle of attack – nearly vertically. Winch failure calls for an immediate action. Mistaken judgment or initiating recovery maneuver with delay leads to rapid airspeed drop and stalling (glider stops „flying" and begins to „fall down"). There is further risk of winch cable tangling into airframe elements.

Stall/spin category is both a high risk situation and a common occurrence [13]. Stalling a glider may be an isolated accident cause, it may also become a co-existing factor during for example incomplete winch launch. Document, on which this elaboration is based, does not specify the number of accidents where stall/spin was a coexisting factor. Recovering a glider from stall/spin is possible, and pilots are trained to do so. Such recovery is always at the cost of rapid descent and airspeed increase. Therefore if stall/spin occurs during winch launch or landing approach, it is impossible to recover – collision with the ground will take place before glider regains stability.

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[9] Urząd Lotnictwa Cywilnego, *Sprawozdanie o stanie bezpieczeństwa lotnictwa cywilnego za rok 2017.*

[10] Urząd Lotnictwa Cywilnego, *Sprawozdanie o stanie bezpieczeństwa lotnictwa cywilnego za rok 2017.*

[11] Urząd Lotnictwa Cywilnego, *Sprawozdanie o stanie bezpieczeństwa lotnictwa cywilnego za rok 2017.*

[12] European Aviation Safety Agency, *Annual Safety Review 2018.*

[13] European Aviation Safety Agency, *Annual Safety Review 2018.*

Accidents during landing

Most glider accidents in Poland – about 70% (both in 2017 and the preceding decade) took place while performing airfield landing or outlanding[14]. Specific danger at this phase of flight is losing airspeed at critically low altitude. This decreases lift and causes stalling. Depending on specific situation this may manifest itself in descent rate increase and „hard landing" or may result in nosedive. Table 1 shows the airspeed values required by certain glider types to stay aloft without stalling or spinning. 30% of accidents in 2017 took place during outlanding[15]. Such a maneuver requires the pilot to choose the safest place – usually a crop field or meadow, location which may turn out too small for stopping the glider after touchdown. In case of inevitable collision with tree, building or other solid obstacle once on the ground, pilots are taught to turn the glider so that the wing hits an obstacle first. There is also a technique called "ground loop". This requires pressing the wing against the ground, so that a glider rotates around a wingtip. Ground looping is an emergency maneuver and there is a risk of breaking glider's structure. Therefore some pilots may choose to land with landing gear retracted. Glider will then make a belly landing, and use friction to stop at a short distance. During belly landing, the glider becomes unsteerable once on the ground. Taking into account forces acting on pilot's spine, it is safer to land with landing gear down. Wheel is the only element absorbing shock in vertical axis. Depending on glider type, there may be a shock absorber, rubber ropes or just the tire flexibility in use. Landing with retracted wheels leaves nothing to absorb the force, which is fully transferred to pilot's body by the rigid fuselage. Glider seat is hard, only sometimes lined with slim pillow. There are energy-absorbing foams available, but these are rarely used to cover glider seats. Irrespective of terrain, it is safer for the spinal column to land with gear down and resort to a ground loop if necessary. Keeping landing gear retracted is advised only in case of ditching, when gear down may cause a turnover and make it impossible to leave the cockpit in shallow water.

Possible mechanism of injury

If the glider hit a solid obstacle, and the airframe is significantly broken, rescue teams should expect any kind of high-energy polytrauma.

In case of „hard landing" – touchdown with high decent rate – spine injury is the major risk. The exact direction of traumatic force has to be assessed in relation to pilot's position in the cockpit. In high-performance gliders position is nearly supine. Spine injury risk is increased in case of landing with retracted landing gear.

If the glider hit the ground nose-first, pilot's body got exposed to significant deceleration. Seat harness is static – occupant should not move out of the seat. Top harness belts run along shoulders and clavicles, the lower belts run along the abdomen (higher than in cars). Harness belts may have various width, but even the most narrow – one inch wide – have the greater total body contact area than car seatbelt.

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[14] European Aviation Safety Agency, *Annual Safety Review 2018*.

[15] Urząd Lotnictwa Cywilnego, *Sprawozdanie o stanie bezpieczeństwa lotnictwa cywilnego za rok 2017*.

It is possible that pilot suffered head or neck injury. Glider pilots use no helmets, and the head is in close proximity to canopy. In some glider types it is impossible to turn the head to the side in baseball cap – peak will hit the canopy. Not all gliders are equipped with headrest limiting the cervical spine whiplash-hyperextension.

Cockpit levers are shaped and placed in such way that the risk of injuring the pilot is minimized. If cockpit structure gest fractured, sharp pieces of wood or composite materials may inflict laceration or even penetrating wounds. During an accident, damage of control surfaces may move flight controls beyond their initial movement range – pilot's hand or thigh may be pressed by the steering column against cockpit sidewall.

Rescue action after glider accident

Rescue action should begin with ensuring that the medical team is safe. If the accident took place on the airfield, medics are allowed to enter the area after being granted permission by airfield staff. Obviously, if the ambulance is called, the place is immediately secured in terms of flight operations. However if several gliders were airborne at the time of accident, they have to land – it is impossible to order glider pilots to stay aloft or redirect them to another airfield. General aviation airstrips are so large, that it is hard to imagine a situation where any landing would delay rescue action. Still it is neither permitted nor safe to drive into airfield at any time and from any direction – even for emergency vehicles. It is further important to assess if the crashed glider requires any stabilization, or if there is a risk of fire (in case of motor-gliders).

It is easy, yet important, to determine how many people were aboard, and if anyone on the ground had been injured. It is good to know, that if a twin-seat glider is flown solo, harness on the back seat is buckled up and tied in such way, that it will not tangle into any moving parts.

While assessing the mechanism of injury it is crucial to determine how long ago did the glider crash. If there was a prolonged search and rescue operation, and the pilot is found still seated inside the cockpit, the situation suggests serious injury. If the pilot (or one of the pilots) bailed out, he or she may have landed on parachute far away from where the glider elements have fallen down.

Every action with patient should follow examination and vital sign assessment. In October 2017, during an EMS congress in Kraków (V Ogólnopolski Kongres Ratowników Medycznych w Krakowie)[16] a workshop simulating glider crash had been organized. The mistake which medical teams kept making, was initiating the action by evacuating the pilot with the use of backboard. Current medical knowledge tends to withdraw from routine use of the board, underlining it may be harmful in several injury mechanisms and has no relation to neurological outcome[17]. Quick exclusion of potential massive bleeding at the beginning was also frequently neglected.

It is easy to access the pilot in glider cockpit, even when the fuselage is lying on its sideboard. There should be no technical problem with trauma examination, administering

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[16] http://www.ratownicymedyczni.com/piaty-kongres/warsztaty.html, access on 15.03.2019 r.

[17] M. Hauswald, G. Ong, D. Tandberg, Z. Omar, *Out-of-hospital Spinal Immobilization: Its Effect on Neurologic Injury*, „Academic Emergency Medicine" 1998, nr 3, s. 214–219.

oxygen, initiating fluid infusion and drug therapy. Only the access to lower legs may be somewhat limited. Currently in Poland paramedics are allowed to use a wide variety of pain-killing drugs (including fentanyl) and use colloid fluids for treating blood loss[18]. Given the speed and energy of the accident, it is advised to make a full trauma examination. Its result helps to choose the proper transport manner and position, along with target destination. The abovementioned simulation showed, that the most stable way of extricating the pilot is with the use of parachute harness, which are easy to unbuckle once outside the cockpit. It is crucial to effectively stabilize the cervical spine, and to make a single move in single axis. Currently the cervical collar is considered an extrication device, and is no longer necessary after placing the patient on backboard or stretcher. Before pulling the pilot out, it is crucial to make sure that: seat harness is unbuckled, feet are not trapped between rudder pedals and that no fractured element may interfere with body movement. Obviously if safety or comfort of rescue action requires bending or cutting any glider element – it is wise to do so. If upon rescue team's arrival the pilot is outside the cockpit, it is advised not to touch the glider – position and state of control surfaces and other elements is helpful in later determining the accident cause.

Glider pilot can have no major health issues. Both student-pilot in training, and licensed pilot are obliged to pass certified medical examination. For glider pilots, a class 2 medical certificate is required. There are very detailed procedures describing criteria of granting certain classes of medical certificates. What is important for rescuers, is that any major issues with cardiovascular, respiratory and nervous systems are excluded. Pilot may have a certain sight defect corrected by glasses or contact lenses. There is one more factor important for therapeutic decisions – glider pilot does not have to be an adult.

Conclusion

Data presented in the article derives both from knowledge in the field of soaring and emergency medical rescue. In case of glider accident the effectiveness of medical rescue action will be increased if rescuers are familiar with the way a glider is built, equipped and aware of its performance capabilities and possible mechanism of injury. In 2017 in Kraków, Poland the author organized a workshop simulating glider accident. It led to very clear conclusion, that there is virtually no awareness among rescue team members about general aviation accidents. Even basic knowledge about airframe and specific risk for people onboard makes it significantly easier to plan air crash victim examination and treatment.

Information from this article is particularly valuable for rescue team members, who serve in the area close to an airfield. Knowledge presented is essential for rescuers and paramedics offering medical support of air races and airshows – in Poland there are several dozens of such events each year.

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[18] *Rozporządzenie Ministra Zdrowia z dnia 20.04.2016 w sprawie medycznych czynności ratunkowych i świadczeń zdrowotnych innych niż medyczne czynności ratunkowe, które mogą być udzielane przez ratownika medycznego*, Dziennik Ustaw Rzeczypospolitej Polskiej, Warszawa, dnia 27.04.2016, poz. 587.

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STRESZCZENIE

Marek Siuta

Wypadek szybowca – postępowanie ratownicze

Wprowadzenie. Inspiracją do podjęcia problematyki będącej przedmiotem artykułu była analiza programów szkolenia ratowników medycznych oraz obserwacje uzyskane w czasie prowadzonych autorskich warsztatów z postępowania w sytuacji wypadku lotniczego. Wynikało z nich, że wiedza na ten temat jest wśród ratowników medycznych znikoma.

Problem badawczy i metoda badawcza. Głównym celem artykułu była analiza i synteza danych na temat specyfiki postępowania ratowniczego po wypadku szybowca. Badania miały charakter teoretyczny i interdyscyplinarny. Polegały na usystematyzowaniu i zintegrowaniu wiedzy z zakresu szybownictwa i ratownictwa medycznego.

Analizy były oparte na literaturze przedmiotu, danych technicznych statków powietrznych, danych statystycznych oraz doświadczeniu własnym autora jako lotnika i ratownika. Dotyczyły problemów specyfiki lotów i lądowań, wyposażenia szybowca, mechanizmów urazu oraz prowadzenia akcji ratunkowej po wypadku.

Wyniki. Przeprowadzone analizy danych z różnych źródeł i ich synteza poszerzają i systematyzują wiedzę na temat wypadków z udziałem szybowca. Wykazano – na poziomie teoretycznym – że istnieje związek pomiędzy wiedzą na temat statku powietrznego a skutecznym postepowaniem ratowniczym w sytuacji wypadku z jego udziałem.

Wnioski i podsumowanie. Dane zawarte w artykule mają charakter zarówno poznawczy, jak i aplikacyjny. Mogą stanowić uzupełnienie wiedzy ratownika medycznego w indywidualnym podnoszeniu swoich kwalifikacji jak i być przydatne w opracowywaniu szkoleń dla zespołów ratownictwa medycznego. Mogą także stanowić punkt wyjścia do badań empirycznych, których celem byłaby dogłębna weryfikacja przedstawionych w artykule zależności.

Słowa kluczowe: szybownictwo, szybowiec, wypadek lotniczy, ratownictwo medyczne.

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