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Summary

Rescue operations in inaccessible environments involve a significant portion of the activity of an Operations Room, located close to a mountain and hill environment. The stratification of the incidents that occur, typically represented at the Lakes Emergency Operations Room (Lombardy Regional Emergency Service), requires operators to acquire specific technical and technological skills, in addition to the skills already available from the HEMS services.

If it is impossible to receive geographical coordinates by sharing them with the user (use of special apps for smartphones, availability of GPS, etc.), the Receivers of the Operations Room and the personnel involved in the rescue operation must know how to share deductive search tools, based on structured interviews and search methods that reduce as much as possible the possibility of error in identifying the location of the event. The effectiveness of the identified tool is testified by the success of a rescue intervention within average times comparable to the direct availability of geographical coordinates at the source of the rescue service.

Introduction

The demand for rescue in inaccessible environments has grown in recent years in response to the increase in certain activities that take place in mountains and in inaccessible environments: mountaineering, climbing, skiing, hiking, trail running, mushroom picking,

paragliding (Yarwood R., 2012).

Nowadays, search and rescue (SAR) missions very often overlap with emergency medical service operations, in which victims are guaranteed medical and nursing care in addition to material aid. Search and rescue can be carried out with special means, which can also be used in hostile and inaccessible environments. At the same time, the most appropriate medical care is guaranteed. It is precisely the possibility of carrying out medical interventions in inaccessible areas that characterise modern civil search and rescue techniques and essence.

During the First World War, systematic rescue operations with aircraft were not possible. The poor technology and limited range of the aircraft made such missions very difficult. However, a few rescues were carried out, usually with a high degree of heroism.

The first coordinated air rescue operation involved American soldiers during the Nicaraguan War in 1927. Search and Rescue missions were organised for the first time, employing both ground and airborne personnel.

In an attempt to facilitate rescue in any place and under any circumstances, the aviation industry embarked on research into new designs. In 1932, a rescue with the new Autogyro, invented by Juan de la Cierva in 1923, was tested for the first time.

During the Second World War, the Americans and Germans prepared numerous aircraft in search and rescue trim. Most of the rescue squadrons were fleets of seaplanes, which could land directly near the shipwrecked people because of their technical characteristics.

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In Italy, too, the Regia Aeronautica was able to find, rescue and transport 13,000 soldiers during the war years.

It was not until the Korean War and especially the Vietnam War that a significant number of search and rescue missions were introduced. New and better-performing helicopter models could be relied upon. In addition, some of these helicopters were designed specifically for use in search and rescue missions, and were equipped with all the technology needed to improve their rescue performance.

However, the first step in rescuing people in difficulty in an inaccessible environment is locating the injured person accurately. Nowadays, various resources are available, including applications for smartphones, which can automatically send the geographical coordinates of the call point (Mosa A.S.M., 2012). In order to function, these devices must have the availability of valid mobile data network coverage. In all other cases, geographical coordinates can only be communicated if the user has devices such as Global Positioning Systems or Personal Beacon Locators. In some cases, the most popular social networks such as Messenger, Facebook or Whatsapp have even been used to find missing persons (Pfau L.D., 2013).

Theories on how to conduct a search for the wounded and missing originated during the Second World War. Kelly compiled statistics on the behaviour of missing persons and published them in 'Mountain Search for the Lost Victim', the first bibliographic reference for search and rescue in inaccessible terrain (Kelley D, 1973).

For these reasons, the Italian Civil Search and Rescue, active in a complex mountainous area such as the one characterising the peninsula, already had 46 helicopter bases in 2007, 26 of which specialised in search and rescue missions in impervious environments. The crews of these helicopter bases were made up of medical (resuscitator) and nursing staff, as well as a technician from Soccorso Alpino (CNSAS) (Mariangeli et al, 2007).

Especially in the case of lack of complete location information, the correct search strategy can make the difference in determining the success or failure of the mission. There are three terms that are commonly used in search strategies: Point of Last Seen (PLS), Last Known Point (LKP) and Initial Planning Point (IPP). These elements should always be included in search and rescue methods to improve the probability of success. In addition to

these concepts applicable on a small and medium scale, complex probabilistic calculations are also described for locating people over large areas or at sea (Cooper D.C., 2003).

In recent years, search and rescue has also benefited from the use of robotic resources and Unmanned Aircraft Systems, known as drones, which can work alongside ground personnel and Search and Rescue aircraft. The use of this type of aircraft has been acclaimed due to the possibilities offered by new technologies (night flight, thermal imaging, automatic search capabilities) in the total absence of any risk to human personnel (Lin L. et al, 2010).

In this article we would first of all like to briefly analyse the reality of Search and Rescue in the area of competence of the Sala Operativa Emergenza Urgenza dei Laghi (Como Villaguardia). In the light of the above and of the data in our possession, we would like to reflect on the methods used to locate the person in need of care.

Materials and Methods

The data useful for analysing and drafting the article were extracted by querying Beta 80's Emergency Management software, which is used to manage the activities of the Lakes Emergency Operations Room.

A retrospective analysis was carried out of all the events that occurred in an impervious environment, from 1 January 2017 to 31 December 2017, searching for them based on the "impervious" tag inserted in the main page of the event that generated the relative mission. The data were extracted with appropriate queries and cleaned of sensitive data and all elements that would have allowed the anagraphic identification of patients.

Four hundred and three events were extracted and the notes of each intervention were examined in order to better select the cases of technical rescue with activation of the helicopter or the volunteers of the Corpo Nazionale del Soccorso Alpino e Speleologico. Of these 403 interventions, 164 involved the use of helicopters (41%).

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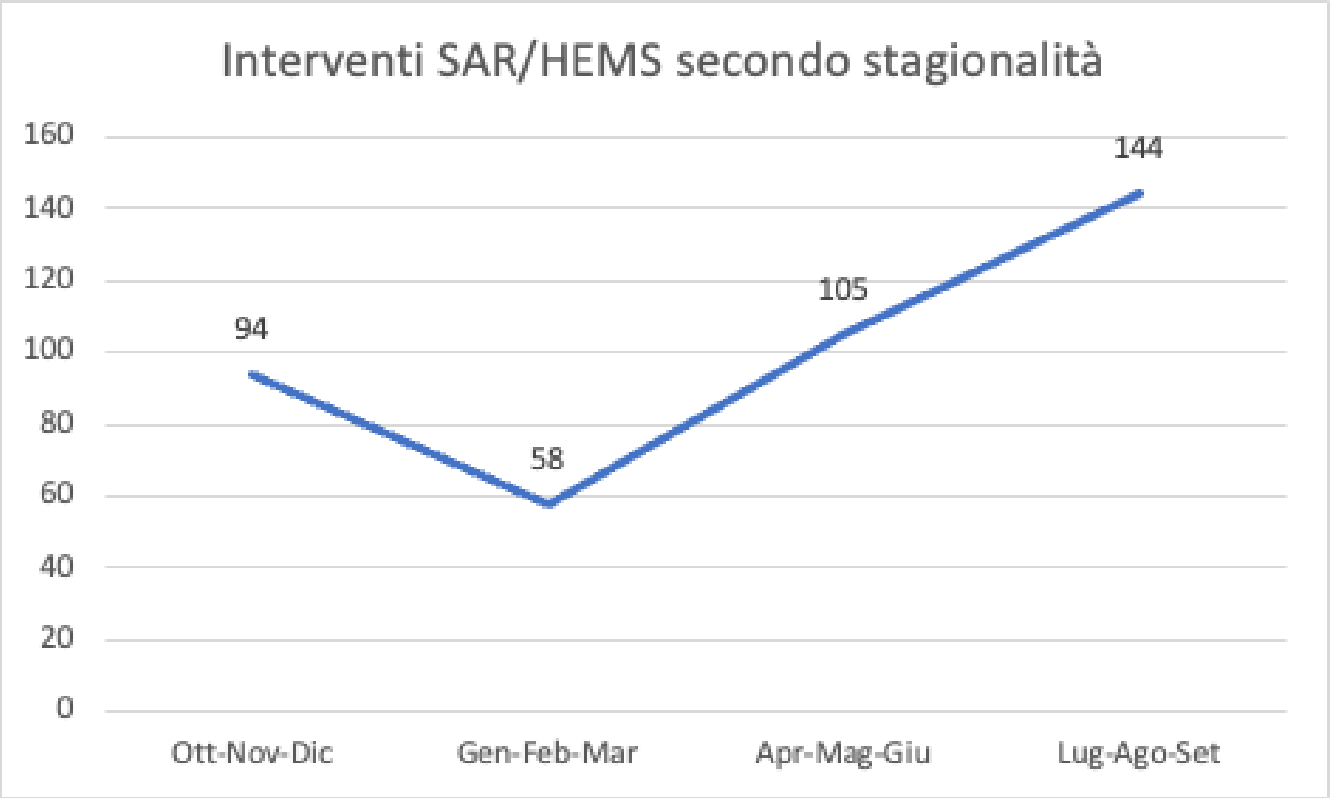
Results

The stratification of interventions follows a typical seasonality, with 14% occurring in the first quarter, 26% in April, May and June, 36% in July, August and September and 23% in the last quarter of the year.

Eighty-four percent of the incidents occurred after 12 noon and 20% after 5 pm, confirming claims in the literature about the increased likelihood of incidents during afternoon hours (Carpenter J., Thomas F., 2018).



Seasonal intervention by the local HEMS crew

Sixty-three percent of the incidents involved hiking accidents on footpaths, 10% involved accidents on via ferrata, mountaineering or rock climbing routes, while the remainder consisted of other incidents, such as skiing accidents, mushroom picking accidents, or accidents while carrying out work, which occurred in an inaccessible environment. The significant difference between this figure and the national trend can be explained by the particular type of terrain of the SOREU dei Laghi, which is typically inaccessible but widely frequented by both professionals and sportsmen.

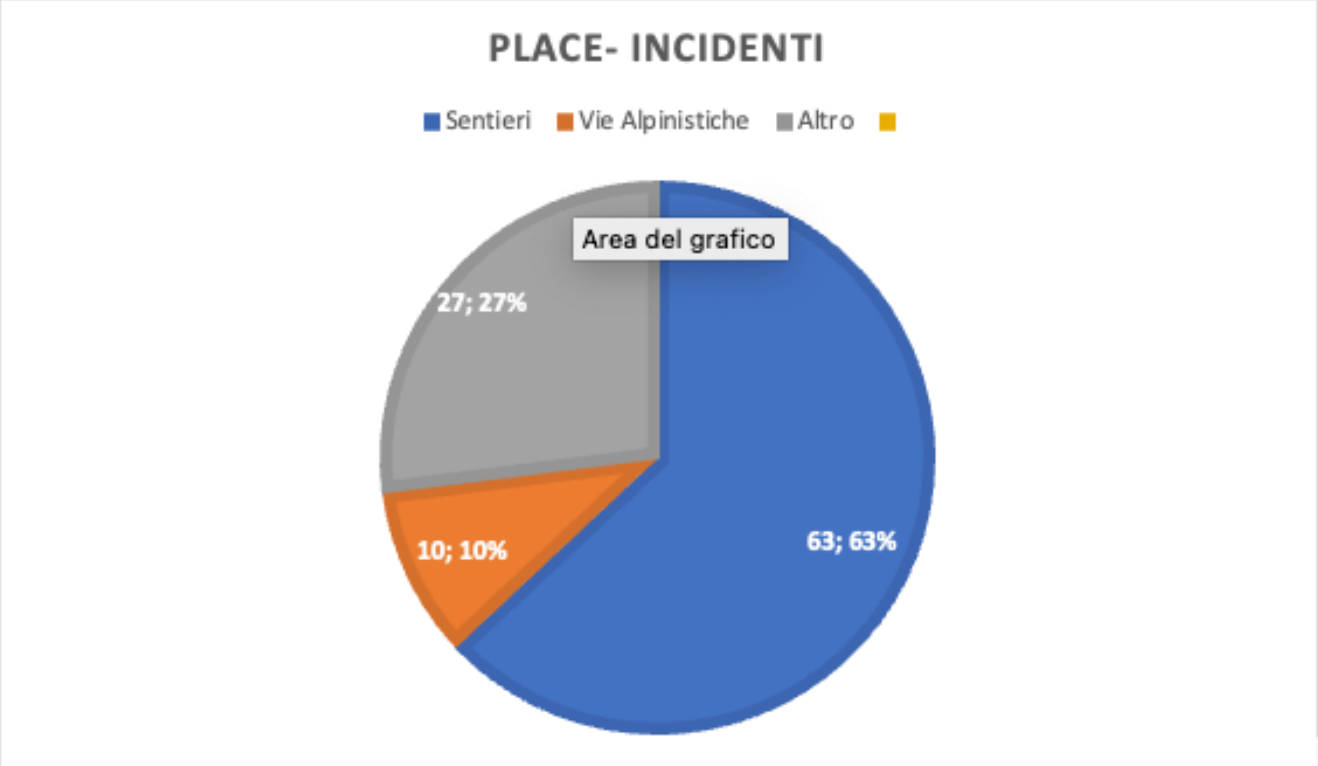
Of all the incidents examined, 41% required helicopter intervention, and it was on this type of intervention that the subsequent analysis focused.

It was decided to divide the events involving helicopter intervention according to the following stratification: localisation without precise references, localisation using coordinates provided by the user, identification of the rescue site using a precise description of the location provided by the caller.

To calculate the average arrival time of the helicopter, the following cases were excluded,

which required a large number of hours for the recovery of the patient and can therefore be defined as special events.

1. Nearly 21-hour operation to rescue several people stranded in a gully above 2,000m
2. 13-hour operation to recover a patient from a paragliding accident
3. 21-hour search operation from the previous evening for a missing person, involving two helicopters
4. 9-hour intervention to search for a patient who was completely unable to describe his location, during evening hours
5. 4-hour intervention for a lost person who had no geographical reference
6. 15-hour search operation for a person who had fallen into a wooded gully with an unknown location



Place of incidents by interventions: Alpine ways, Pathways, others.

Generally, the timing of arrival includes the following features:

- Incoming call processing at SOREU: 1 minute 30 seconds on average
- Helicopter activation: 2 minutes
- Preparation and take-off: 5 minutes

For events occurring in clearly defined locations (mountain routes, climbing gyms, via ferrata), or where geographical coordinates were provided (only 5 cases), the average time taken for rescuers to arrive at the scene (activation, flight, reaching the injured person) was 41 minutes 05 seconds from the first call.

In all other cases, localisation took place without the aid of technological aids (GPS, applications) or precise toponyms, but thanks to the descriptive identification of the injured person's position. In these interventions the average time of arrival was 43 minutes and 47 seconds.

Discussion

The Sala Operativa Urgenza Emergenza dei Laghi territory is divided between the provinces of Varese, Como and Lecco and has a mountainous region of considerable extension. The main mountain groups are located between the provinces of Como and Lecco: Grigne, Valsassina, Monte Legnone, Alto Lario Occidentale, the Italian portion of Lake Lugano, Val d'Intelvi and the Triangolo Lariano mountain range. Finally, there is a mountainous-hilly region in the province of Varese that is decidedly impervious. In these areas and especially on the Southern Grigna, there is a lot of hiking and mountaineering activity, both in summer and winter.

Especially in Valsassina (Piani di Bobbio, Zucco Pesciola and Campelli) and the Southern Grigna, there are many classic climbing sites and sport routes (high difficulty intermediate protection guaranteed by the presence of cemented or resin-coated fixes). In the province of Lecco there are also: 1 via ferrata above the city, 1 above the town of Valmadrera, 5 via ferratas on Mount Resegone, 1 on Mount Due Mani, 1 on the Northern Grigna. There are equipped routes for experts on the Southern Grigna. There are two via ferratas in the province of Como: one on Monte Grona, near Menaggio, and the other on the Corni di Canzo, in the Larian Triangle. All the routes mentioned are highly frequented.

Search and rescue in rough terrain is a major challenge for both civilian and military emergency services. In regions with significant mountain coverage, especially on fine summer weekend days and especially in the afternoon hours, there is an obvious peak in rescue requests. In such cases, fatigue and the resulting reduced stamina and alertness can lead to accidents of various kinds.

Advanced rescue techniques, such as those involving a helicopter and the use of a winch,

are used in these interventions (Carpenter J., Thomas F., 2018). This type of rescue usually occurs in mountainous areas (Alps and mountain ranges of the United States of America), but cases of rescue at high altitudes in Nepal and Himalaya are also described (Brodmann Maeder M.M. et al., 2014).

Helicopter rescue, which is very common nowadays, is generally demanding and risky, if we consider that the number of aviation accidents that occur during this type of mission is much higher than in other types of helicopter flight. The risk percentage increases even more if the missions take place during bad weather or in dark conditions (Gordon H.W., 2018).

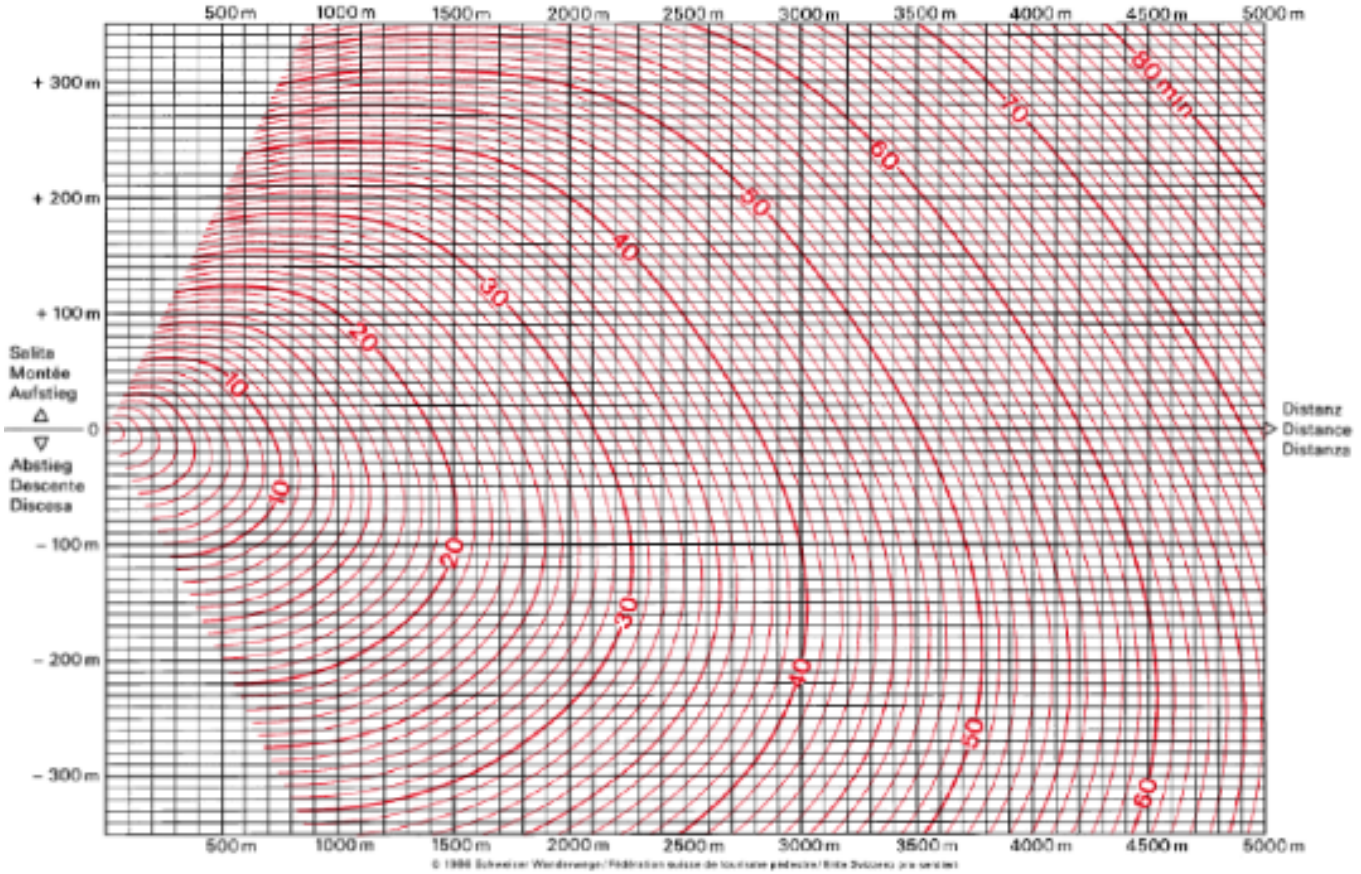
The difficulty of interventions in an impervious environment represents a high risk for rescuers (Ciesa M. et al., 2015), which should prompt a judicious prevention campaign and activate all the self-protection and Crew Resource Management techniques that rescuers and aircraft crews should implement to prevent accidents. Debriefing becomes in this case a fundamental element for the review of the event and the learning from possible faults or errors (Grissom C.K., 2006).

In a good percentage of cases, accidents occur while practising extreme sports (Gosteli G. et al, 2016). Although many accidents involve a large number of people who possess a low level of skill and who therefore find themselves in danger due to their own unpreparedness, regardless of the difficulty of the terrain (Lack D.A., et al. 2012). Recent reports from the Italian Corpo Nazionale del Soccorso Alpino e Speleologico show a preponderance of accidents occurring to people practising hiking activities: in 2009 36.4% of accidents in the mountains involved hikers (CNSAS, 2009), while in 2016 the cases increased to 40% (CNSAS, 2016). Falling was accounted for 35.5% while loss of orientation was found in 11% of all accidents. In 2016, mountaineering accidents accounted for 6.9% while other types of accidents, such as events involving mushroom seekers, decreased from 4.6% in 2006 to 2.8% in 2016, probably due to the numerous awareness campaigns on risk assessment and prevention.

Locating missing persons

How to locate missing persons if you do not have geographical coordinates provided by the patient? Or how to proceed if the patient does not have a Smartphone App able to launch alarm calls? What knowledge should the operator of the Operations Centre have?

Knowing the basic principles of conducting a good semi-structured interview is the first step in locating the missing and then rescuing them.



People who are lost normally follow tracks or paths, with the exception of children or people with dementia, who tend to wander for no apparent purpose, although they are usually found within 700-800 metres of their starting point (Hill K. A., 2007). Instead, people in distress tend to descend by the shortest route (Phillips K., et al, 2014), following the 'water drop' mode (faster but steeper route down).

The literature (Club Alpino Italiano, Schweizer Wanderwege, 1986) shows the walking times of hikers uphill and downhill at different altitudes. It is therefore possible to calculate the height differences of people requiring rescue, knowing only their starting point and their walking time, both uphill and downhill. Below 2,500 metres (generally the maximum altitude for the elevations located in the area covered by SOREU dei Laghi) there is a difference in height of about 350 metres uphill for less than 3 km and about 500 metres downhill.

Human behaviour is generally recurrent and follows common lines of conduct. Intersecting the travel times with the various known points (Initial Planning Point, Last Known Point, Timing) and with the dislocation of the various paths, it will be possible to identify more or less limited areas in which the patient is likely to be found.

Figure 1 Travel times in altitude and distance according to altitude

In almost all cases (97%), since there were no geographical coordinates available for localisation, the research was based on the completion of a semi-structured questionnaire, based on the identification of the basic elements, reported in the literature, useful for localising the patient.

The sequence of questions posed to the user was developed based on guidance provided in the literature, such as that suggested by the IAMSAR (International Aeronautical and Maritime Search and Rescue) manuals and the Land Search and Rescue Addendum (2016).

Conclusions

In the cases presented, the timing of the arrival of the rescuers at the scene was uniform even though the geographical coordinates of the event location were not available. This was due to the effective deductive localisation of the event location, based on the semi-structured questionnaire implemented. The geographical coordinates to which the helicopter should be sent were extrapolated by the operators at the centre, based on the information collected, identified on the cartographic software available to all the operators and then sent by radio to the crew in the air. The identification of people in distress and their rescue were conducted quickly, effectively and with minimal exposure to those risks that can increase with the passage of minutes and a delay in arriving at the scene.

This means that knowledge of semi-structured interview techniques based on international literature and geographical knowledge of the search area are key factors in being able to quickly identify and rescue the casualty. This knowledge should therefore form part of the basic and advanced training of every emergency room operator, including those involved in search and rescue in mountainous or hilly environments.

Table 1. Semi-structured questionnaire for searching for missing persons in the absence of geographical coordinates provided by the patient.

Bibliography

Broadmann Maeder M.M., Basnyat B., Harris S. (2014). From Matterhorn to Mt Everest: Empowering Rescuers and Improving Medical Care in Nepal. Wilderness & Environmental Medicine 25:177-81.

Carpenter J., Thomas F. (2018). A 10-Year Analysis of 214 HEMS Backcountry Hoist Rescues. Air Medical Journal. 32(2):98-101

Ciesa M., Grigolato S., Cavalli R. (2015). Retrospective Study on Search and Rescue Operations in Two Prealps Areas of Italy. Wilderness &

Environmental Medicine 26:150-58

Cooper D.C., Frost J.R., Quincy Robe R. (2003). Compatibility of Land SAR Procedures with Search Theory. U.S. Department of Homeland Security United States Coast Guard Operations (G-OPR) Washington, D.C.

Dennis E. , Kelly D. (1973). Mountain Search for the Lost Victim. Montrose, CA

Gordon H.W. (2015), Civilian Helicopter Search and Rescue Accidents in the United States: 1980 Trough 2013. Wilderness & Environmental Medicine 26:544-48.

Gosteli G., Yersin B., Mabire C., Pasquier M., Albrecht R., Carron P.N. (2016). Retrospective analysis of 616 air-rescue trauma cases related to the practice of extreme sports. Injury, Int. J. Care Injured. 47:1414–1420

Grissom C.K., Thomas F., James B.. (2006). Medical helicopters in wilderness search and rescue operations. 25(1):18-25

Hill K. A. , et al (2007). Managing the Lost Person Incident. Centreville, VA: National Association of Search and Rescue.

International Maritime Organization (2016). International Aeronautical and Maritime Search and Rescue Manual. International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO). Vol. I-II-III

Kelley D. (1973). Mountain Search for the Lost Victim. Search and Rescue Magazine

Koester R. J. Lost Person Behavior (2008). A Search and Rescue Guide on Where to Look for Land, Air, and Water. Charlottesville, VA

Lack D.A., Sheets A.L., Entin J.M., Christenson D.C. (2012). Rock Climbing Rescues: Causes, Injuries, and Trends in Boulder County, Colorado. Wilderness & Environmental Medicine. 23:223-230

Lin L., Roscheck M., Goodrich M.A., Morse B.S. (2010). Supporting Wilderness Search and Rescue with Integrated Intelligence: Autonomy and Information at the Right Time and the Right Place. Computer Science Department. Brigham Young University.

Mariangeli F., Tomei M., Ursini M.L., Ricotti V., Varrassi G.. (2007). Helicopter Emergency Medical Service in Italy: Reality and Perspectives. Air Medical Journal. 26(6):292-98

Mosa A.S.M., Yoo I., Sheets L. (2012). A Systematic Review of Healthcare Applications for Smartphones. BMC medical informatics and decision making. 12(67)

National Search and Rescue Committee (2016). Land and Search Addendum. International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO). Vol I

Philips K., Longden M.J., Vandergraff B., Smith W.R., Weber D.C., McIntosh S.E., Wheeler A.R. (2014) Wilderness search strategy and tactics. Wilderness & environmental medicine. 25(2):166-76

Pfau L.D. (2013). Wilderness Search and Rescue: Sources and Uses of Geospatial Information. Penn State University

Setnicka T. (1981). Wilderness Search and Rescue: A Complete Handbook. Boston, MA: Appalachian Mountain Club

Twardy C.R., Koester R., Gatt R. (2006). Missing Person Behaviour An Australian Study. Final Report to the Australian National SAR Council.

US National Park Service Data: Annual Search and Rescue Reports. Data from 2003-2012. Available at: www.nps.gov/foia.htm. Accessed January 29, 2014.

Yarwood R. (2012). One moor night: emergencies, training and rural space. Area. 44:22–28.

Van Tilburg C. (2017). First Report of Using Portable Unmanned Aircraft Systems (Drones) for Search and Rescue. Wilderness & Environmental Medicine. 28:116-18

Salas, E., and Fiore, S. (2004). Team cognition: Understanding the factors that drive process and performance. American Psychological Association Washington, DC

Setnicka, T. J. (1980). Wilderness Search and Rescue. Appalachian Mountain Club.

Goodrich, M.; Morse, B.; Gerhardt, D.; Cooper, J.; Quigley, M.;

Adams, J.; and Humphrey, C.. (2008). Supporting wilderness search and rescue using a camera-equipped mini UAV: Research Articles. Journal of Field Robotics 25(1-2):89-110.

U.S. Coast Guard Research and Development Center (2001). Revew of Search Theory: advances and applications to search and rescue decision support. U.S. Department of Transportation. United States Coast Guard. Washington, D.C.