CAPSTONE REPORT

MOUNTAIN EMERGENCY MEDICAL SERVICES IN INDIA:

A SCOPING REVIEW

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INTRODUCTION

The Ayushman Bharat Pradhan Mantri Jan Aarogya Yojana (PMJAY) aligns with the Sustainable Development Goals (SDGs) that seek to achieve universal health coverage globally by 2030(1). Universal health coverage aims to provide efficient healthcare services to all citizens, regardless of location. While I write this paper, hundreds of people are stranded, and many are left to die due to floods in the eastern Himalayas. The states of Himachal Pradesh and Uttarakhand suffered a similar extensive loss of lives in a time not more than four months ago in July and August 2023. India being the 7th largest country in the world has 30% of its land covered by mountains. It is worth noting that in recent years, there has been a significant surge in leisure activities in mountainous regions, accompanied by a rise in accidents and the subsequent need for mountain rescue teams. Data from the Office of the Registrar General and Census Commissioner, India states that in 2020, 3.4% of deaths in Himachal Pradesh were due to medical intervention by untrained functionaries(2). Likewise, the percentage of deaths accountable by untrained functionaries in Uttarakhand and Jammu & Kashmir are 7.1% and 12.3% respectively.

When in the wilderness, search and rescue operations need the support of medical emergency teams to deliver effective care and minimize disability. Harsh climatic conditions, rugged geological terrain, hampered modes of communication, and scarce rescue resources and transport modalities may affect the patient's prognosis(3). Managing casualty incidents in mountainous areas presents unique environmental and logistical challenges that demand adaptation and innovation by caregivers to deliver the most suitable emergency care.

Consistent readiness is key, requiring periodic review of knowledge, planning, equipment, and training. It is worth noting that the existing scientific literature on mountain emergency medical services is rather limited. In a country as capable as India,

helicopter-based emergency medical services offer significant potential, potentially averting preventable deaths. This study explores the landscape of emergency medical services in the Himalayan regions of India and assesses international organizations engaged in mountain emergency medical services. A detailed examination of practices in Scotland, Italy, Switzerland, and specifically Bhutan and Nepal are conducted, as their challenges and geographical terrains closely resemble those of the Indian Himalayas. The aim of this scoping review is to construct an evidence-backed roadmap to support the management of medical and surgical emergencies in mountain environments by emergency medical services.

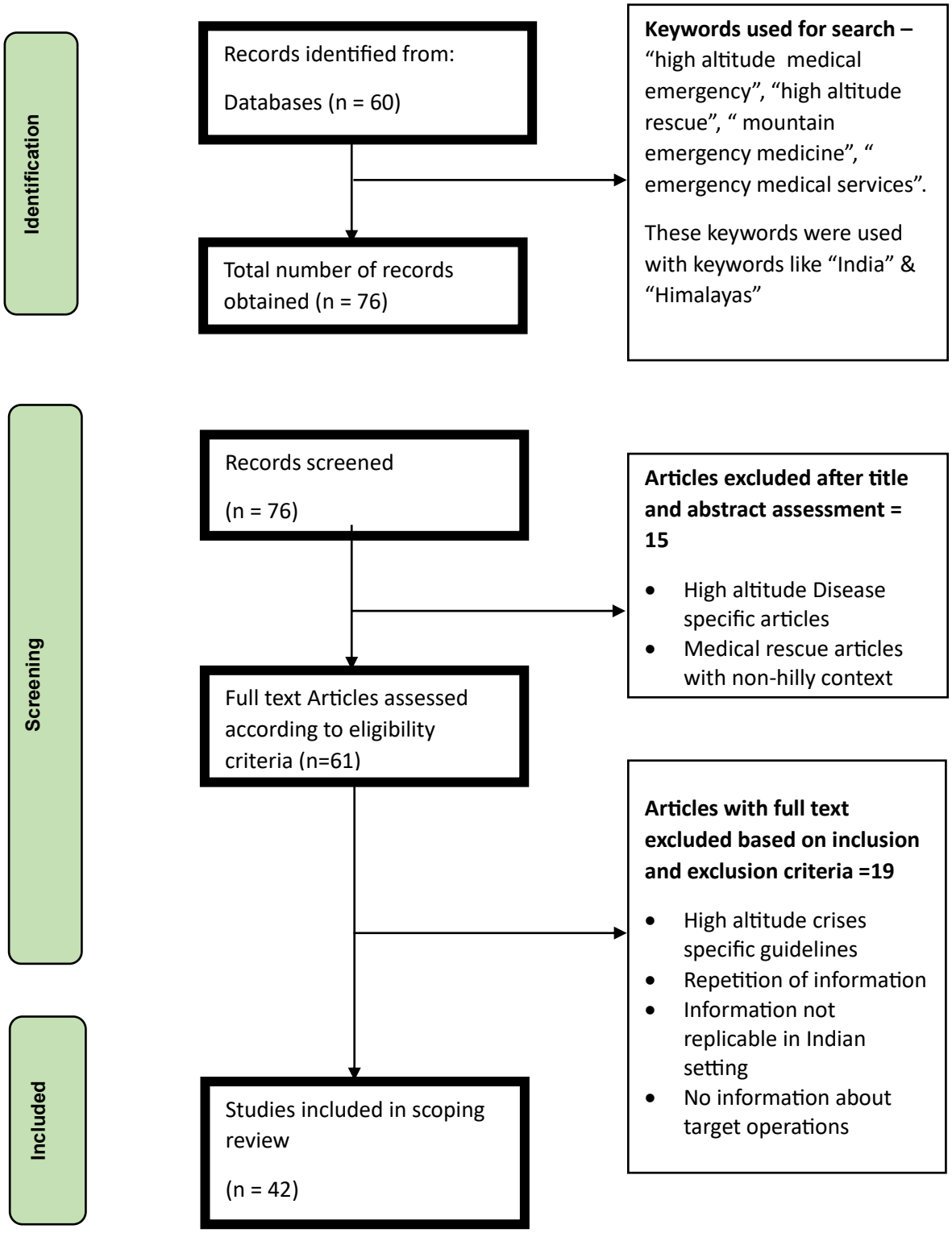
METHODOLOGY

The scoping review was done based on recommended PRISMA ("Preferred reporting items for systematic reviews and meta-analysis") guidelines(4).

Three databases were utilized namely "PUBMED," "Cochrane," and "Google Scholar" for retrieving the articles. Keywords that were used for searching were "high altitude," OR "mountain" AND "emergency medical services" AND "emergency medicine" AND "medical rescue". All these research terms were used in the same format in all the databases. IndiaStat was also used to extract relevant statistics.

This review included articles published between January 2012 to June 2023 and included only those articles which were published in the English language. The articles not providing information on operations of patient transfer and rescue were excluded. The articles which were specific to any one medical emergency were also excluded. The remaining forty-two papers were evaluated for possible inclusion.

PRISMA ROADMAP



RESULTS

EMERGENCY MEDICAL SERVICES: AN OVERVIEW

Emergency Medical Service (EMS) is a branch dedicated to providing out-of-hospital acute medical care and transport to definitive care, that includes quick assessment, skilled medical interventions, and prompt transfer to the appropriate health facility by the most effective patient transfer means to enhance survival and control morbidity(5). The scope of "Emergency Medical Service" has gradually changed over time because of the shift from a fundamentally transportation-focused system (ambulance service) to a comprehensive system that incorporates medical treatment along with transportation services(6). The simplest emergency medical services only involve transporting patients from their location to the closest facility for care.

In emergency medical rescues, diverse practices have evolved over time. The decision of whether to dispatch advanced medical resources to the patient's site or to immediately transport the patient to the hospital is an important factor in establishing an Emergency Medical Service. Based on the level of medical intervention to be done during the pre-hospital time, two approaches have been identified: (1) Stay and play method, (2) Scoop and run method

The French and Belgian emergency mobile resuscitation units are examples of the "stay and play" method, in contrast to the "scoop and run" strategy defined by aero-medical evacuation helicopters like MEDEVAC(7). The principal objective of "scoop and run" treatment generally is to transport the patient within ten minutes of arrival, which has led to the term "the platinum ten minutes" becoming widely recognised in EMT training programmes.

The emergency medical team leadership also shows varied approaches, they can widely be categorized into two primary models:

Physician-led approach – This approach involves direct physician participation in responding to serious emergencies needing more comprehensive medical care than simple first aid. Paramedics may be a component of the system in other applications of this methodology, but they are subject to restrictions on their scope of practice.

Paramedic-led approach - The ambulances are staffed by skilled technicians and paramedics. Patients receive medical care on the spot according to the technician's level of expertise, and their eventual transport to the hospital is determined by their needs and assessment by the technician.

MOUNTAIN EMERGENCY MEDICAL SERVICES

Mountain Emergency Medical Services (EMS) refers to the specialized medical services and response teams that are trained and equipped to provide emergency medical care in mountainous and rugged environments(8). These environments can present unique challenges for emergency medical providers due to factors such as high altitude, extreme weather conditions, difficult terrain, limited communication systems, and meager access to medical facilities.

Key features of mountain EMS, as derived from literature are:

Specialized Training: people involved in mountain emergency medical rescues are trained to operate in high-altitude environments, handle cold weather injuries, manage altitude-related illnesses, navigate challenging terrain, and perform technical rescues like rope and air evacuations(9).

High Altitude Medicine: Cold weather injuries like hypothermia, frostbite, high altitude cerebral oedema and high-altitude pulmonary oedema are expected in such

environments.(10). Mountain emergency medical rescue personnel are trained to manage these conditions and prevent further harm.

Trauma Care: Mountain emergency medical service teams provide advanced trauma care, stabilize patients, and prepare them for evacuation to medical facilities(11).

Communication: Communication is challenging in remote mountain areas with limited cellular coverage(12). Mountain emergency medical service teams use specialized communication equipment to coordinate rescue efforts.

Equipment and Gear: Mountain rescue personnel use specialized equipment like cold-weather gear, climbing equipment, wilderness medicine supplies, and specialized vehicles for access to rugged areas.

Helicopter Rescue: Mountain emergency rescue personnel are trained to work with helicopter rescue crews to ensure patients' safe and quick transport(13).

Search and Rescue: Mountain rescue teams often work in collaboration with search and rescue teams to locate and assist individuals who may be injured or lost in mountainous areas(14).

Safety of patients and team: The harsh environment and high altitude always pose a risk to the lives of the care providers and patients. Continuous alertness and cautiousness is necessary while patient management and evacuation(14).

Collaboration with Other Agencies: Mountain EMS teams often work in collaboration with local search and rescue teams, law enforcement agencies, and other emergency responders to ensure a coordinated and effective response (15).

CURRENT MOUNTAIN EMERGENCY MEDICAL SERVIVES IN INDIA

In most of the mountainous regions of the Himalayas, private ambulances are the only remedy for patient transfers(16). Most of the ambulances are not equipped with any lifesaving equipment and carry no formally paramedics(7). There is no organized service for medical emergency air evacuation in the Himalayan part of India. Private air ambulances are most of the time inaccessible and unaffordable by the local people or these air ambulances not ready upfront to cater to the urgency of the case.

The "**108 Ambulance**" which operates under the banner of "EMRI green health services GVK enterprise", is an extensive ambulance service managed by the Emergency Management and Research Institute across 14 states and union territories in India(17). The main goal of the "108 Ambulance" initiative is to guarantee quick response times, with a target of reaching patients site within twenty minutes in urban region and forty minutes in rural regions(18). The fleet of ambulances includes both Basic Life Support (BLS) and Advanced Life Support (ALS) ambulances. An operation executive and a fleet executive oversee each of the 15 ambulances at the managerial level, with district managers and administrative officers for each district providing further oversight(16). A study showed that, in 2016 the '108' service transported an estimated 12.7 % of obstetric emergencies in Himachal Pradesh(19). The overall time from the call to reaching the hospital was less than 2 hours for 61% of obstetric emergencies in Himachal Pradesh.

Established in 2006, the **National Disaster Response Force (NDRF)** was created to provide specialized responses to natural and man-made disasters. It operates under the leadership of a Director General and is overseen by the Ministry of Home Affairs of the Government of India. The NDRF's exceptional responses to significant events like the devastating floods in Jammu and Kashmir in September 2014, Cyclone Hud-hud in October 2014, the Nepal earthquake in April 2015, and the Bilaspur tunnel accident in

Himachal Pradesh have underscored its outstanding contributions. Presently, the NDRF stands as a distinguished and exceptional force, comprising 1,149 personnel in each of its 16 battalions. Four of these battalions are active in the Himalayan mountains. The 12th NDRF battalion is based in Arunachal Pradesh, with a mandate to cover hill regions in the eastern part of the country. The 13th Battalion is in Ludhiana, Punjab, but its jurisdiction includes the entire Jammu and Kashmir and Ladakh region. Additionally, the 14th and 15th battalions are stationed in Himachal Pradesh and Uttarakhand, respectively, with operational domains in their respective states(20).

The **Indian armed forces** serve the people of India in an uncountable number of ways. Their efforts help save lives and provide much-needed assistance to civilians in remote and challenging mountainous regions, particularly in the Himalayas. The Indian Armed Forces, with their specialized mountain units, logistical capabilities, experienced personnel, and air support, are crucial in conducting mountain emergency medical rescue operations. The armed forces also maintain a cadre of medical personnel, including doctors, paramedics, and nurses, with training in high-altitude and mountain medicine, capable of administering crucial medical care and preparing patients for evacuation. Furthermore, the Army Aviation Corps assumes a pivotal role in mountain rescue operations by deploying helicopters and transport aircraft for the aerial extraction of injured or stranded individuals, surmounting challenging road access limitations.

Six Sigma High Altitude medical services provide specialized medical care to people in the treacherous heights of Kedarnath, Badrinath, Tungnath, and Madhyamaheshwar in Uttarakhand, during pilgrimage times(21). They provide free of cost emergency medical services to the pilgrims and people living in neighbouring regions. They have temporarily established health centers to manage emergencies, as well as ambulances and helicopters to transfer patients. In 2022, Six Sigma Services air evacuated 96 emergency medical

cases from Kedarnath and evacuated 9 cases from Badrinath during the pilgrimage period(22).

A review of mountain emergency medical rescue services in developed and developing countries was done to understand the models of emergency medical services. For this purpose, the various studies were referred to, which are mentioned in Table 1.

Table <1> Models Emergency Medical Rescue Services in developed and developing countries

SUCCESSFUL EXAMPLES OF MOUNTAIN EMERGENCY MEDICAL SERVICES – THE EXPERIENCE OF DEVELOPED COUNTRIES

The **ICAR (International Commission for Alpine Rescue)** is a global panel of specialists on mountain emergency medicine, which has 136 member organizations in over 40 countries(23). The commission was founded in 1948 with the prime goal of improving mountain rescue services and their safety. The work of the organization consists of research and improvement of mountain emergency medicine with a professional mountain rescue approach. This knowledge is transferred to the member organizations and worldwide.

The ICAR MEDCOM's work mainly consists of Researching and improving mountain emergency medicine in a professional mountain rescue environment. It establishes field management guidelines. It has also developed evidence-based criteria for the determination of death by mountain rescue teams(24).

Scottish Mountain Rescue (SMR) is a charity, founded in 1965 as Mountain Rescue Committee of Scotland. Scottish Mountain Rescue is a representative and coordinating body for twenty-five member Mountain Rescue Teams (MRT) in Scotland. The team leader or a senior member of the MRT on receiving an SOS call, will coordinate the

rescue. The team members are called in depending on the requirements of the rescue operation(25). Depending on the scenario, an array of team members can be called in they might be the Search and Rescue Dog Association or the Search and Rescue Aerial Association if drone searches are required. In some cases, a Maritime and Coastguard Agency helicopter or Scottish Cave Rescue Organisation may also be involved.

Scottish Mountain Rescue and the 25 Member Teams spend around 1.5 million pounds annually. On average each rescue costs £2,500, £1,500 of this is donated by the public, £500 from the Scottish Government and £500 by the volunteer team members themselves. The division of these funds was observed to be - equipment for teams (12%), coordination & communication (16%), Insurance for SMR and teams (5%), national training program (9%), funds distributed to teams (58%)(26).

The Mountain Medics California is the only ambulance service in the United States that provides critical-care 4x4 ambulance services with wilderness medicine-qualified personnel and online medical direction. The service model includes field personnel and mobile field clinics. The field personnel move along with the mobile clinic and may reach out to emergency locations when required. They have trained paramedics and registered nurses, physician assistants, and physicians versed in the incident command system.

SUCCESSFUL EXAMPLES OF MOUNTAIN EMERGENCY MEDICAL SERVICES – THE EXPERIENCE OF DEVELOPING COUNTRIES

The **NEPAL AMBULANCE SERVICE (NAS)** is established to respond to the shortcomings created by the lack of a professional patient transfer service or Emergency Medical Response in Nepal(27). Pre-hospital emergency care is provided to patients at the pick-up point or scene of an accident as well as during transport to the closest appropriate hospital. Each patient transfer vehicle is equipped with specialized life-saving equipment and a trained Emergency Medical Technician (EMT)(28).

The **BEAR (Bhutan Emergency Aeromedical Retrieval)** service in Bhutan is to provide emergency medical care and transport to patients with critical illness or injury, as well as those in remote and inaccessible places, to definitive medical care. Currently, the BEAR services are commanded and executed from Jigme Dorji Wangchuck National Referral Hospital in Thimphu, which is itself at an extreme height of 2400m(29).

The BEAR team consists of a team leader, medical officer, flight nurse, and pilot. The team leader is responsible for overall coordination and communication with the Emergency Medical Services Division (EMSD) of the hospital, while the Medical Officer and Flight Nurse are responsible for patient care during transport. The BEAR team meets monthly with EMSD to review all transports and outcomes to ensure continual improvement. The BEAR services are funded by the government of Bhutan and the medical equipment and consumables are obtained from the headquartering hospital.

SYNTHESIS

OPERATIONS OF MOUNTAIN EMERGENCY MEDICAL SERVICES

Safe execution of patient transport and medical intervention in the pre-hospital phase is the result of various coordinated operations taking place simultaneously. To device a roadmap for operations, in this paper, we classify operations of mountain emergency medical services into two categories: Active Operations and Passive Operations(30).

Active operations

Active operations in emergency case rescue include the tangible and mission-critical tasks and responsibilities executed when responding to an emergency incident(5). These activities are intricately linked to the primary goal of rescuing and providing aid to individuals in distress. Active operations are the dynamic, hands-on aspects of emergency response that demand well-coordinated teamwork, rapid decision-making, and the application of training and expertise to achieve the ultimate objective of saving lives.

During active operations, emergency response teams engage in a range of tasks that are directly associated with the rescue and care of patients or individuals in need. These activities may include Communication, Transport and Medical Intervention(31).

Communication: Effective communication is maintained with the emergency response center, healthcare facilities, and other team members to relay patient information and coordinate resources(6). Mountain emergency medical service teams use radios, satellite phones, and other communication tools to stay in touch with command centers and coordinate rescue efforts.

Transport and Evacuation: Once the patient is stabilized, they are carefully moved to an ambulance or medical transport vehicle for safe transfer to a medical facility. Mountain emergency medical service teams may employ helicopters or other aerial assets to evacuate seriously injured or critically ill individuals from remote mountain areas, providing swift transport to medical facilities(32).

Assessment and Medical Intervention: Responders evaluate the condition and medical needs of the patient. This assessment guides subsequent actions and determines the urgency of medical care required. Immediate medical care is administered to stabilize the patient's condition. Depending on the severity of the injuries or medical issues, this may involve basic life support, advanced life support, or specialized treatments(33).

Passive operations

Passive operations refer to the activities and responsibilities that support and underpin the overall functioning and effectiveness of the mountain emergency medical services. Unlike active operations, which involve direct patient care and rescue, passive operations are focused on the administrative, logistical, and infrastructural aspects of emergency medical services(34). These essential tasks ensure the seamless operation of the emergency medical services system and play a crucial role in delivering timely and

efficient emergency medical care(35). Some key components of passive operations are discussed below:

Human resource management: Human resource management is a multifaceted process that involves recruitment, training, performance evaluation, scheduling, safety, and employee relations to ensure rescue personnel are well-prepared, motivated, and capable of delivering high-quality care.

Logistics and Supplies management – equipment maintenance, efficient management of resources, including ambulances, medical equipment, and supplies. This includes inventory control, equipment maintenance, and ensuring that all necessary supplies are readily available for active operations(36). Keeping the ambulance fleet in optimal working condition is essential. This includes regular vehicle maintenance, inspections, and ensuring that ambulances are equipped with the necessary medical equipment.

Finance management: Managing the financial aspects of the system, including budgeting, billing, and reimbursement processes, is critical to its sustainability.

Legal Compliance: This involves ensuring that the emergency rescue system adheres to legal requirements and standards related to medical care, vehicle safety, and operational procedures.

Dispatch and Call Center Operations: This includes maintaining communication systems, managing call centers, and ensuring timely response to emergency calls(37).

Documentation and Record Keeping: Accurate and thorough documentation of patient care is a fundamental part of passive operations(36). This includes maintaining patient records, incident reports, and other necessary documentation.

Quality Assurance and Improvement: Monitoring and evaluating the quality of care provided by the mountain emergency medical services. This includes reviewing patient outcomes, and response times, and identifying areas for improvement.

Facility Maintenance: Ensuring that facilities, such as outreach centres, are well-maintained and ready for patient rescue operations.

Interagency Collaboration: Mountain rescue teams often work closely with healthcare facilities, local law enforcement, fire departments, and other agencies to ensure a coordinated response to mountain emergencies(37).

EMERGENCY MEDICAL SERVICES IN INDIA– A PROPOSED PROTOTYPE

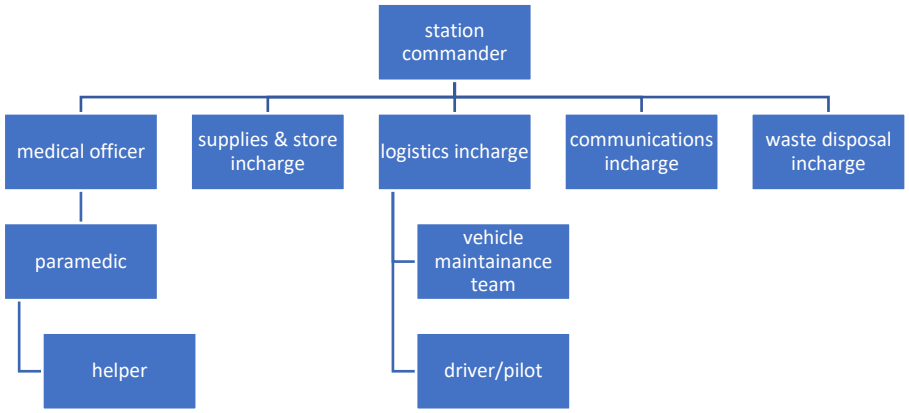
In India, as it is mentioned in the literature review, most of the emergency medical services during the time of disasters are provided by the army and other central forces. There is no functional emergency medical rescue model found for Indian mountainous regions, during normal times. It is a need to design an emergency medical rescue model and implement it in the hilly states of India – Jammu &Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh.

The operations and complexity of the operations can diversify with time and the service-providing team should built keeping in mind all the operations. The recommended framework after this study, is inspired by Bhutan emergency aeromedical retrieval services. The BEAR service is primarily a rescue service for medical emergencies. The geographical terrain and other environmental challenges are similar in the Himalayan mountains of India and Bhutan. Given the similarities in population distribution in hilly regions, varied transport times, and limitations of medical care, it would be more feasible to replicate such a service model. Helicopter emergency medical services are known to decrease the time to definitive treatment(13). The BEAR Team provided services to all regions of the country in its first year with the overall survival rate being 73.1%(38).

The roles and responsibilities of each member of the organization have been decided using the following documents: Classification and Minimum Standards for Emergency Medical Teams, prescribed by WHO(39); National Emergency Life Support provider course manual for paramedics, from the Ministry of Health and Family Welfare of India(40); and multiple articles from ICAR MedCom.

Like the BEAR service model, this study also proposes 2 tier organization for the rescue of medical emergencies in the mountains. From an organizational and hierarchical point of view, mountain emergency medical services may have an organogram at two different levels: (1) EMS stations, and (2) Head office.

At the EMS station:



The **station commander** is the head of the outreach centre where the emergency medical team is situated. He/she is responsible for all the active operations of each rescue case.

Responsibilities:

- Ensure the all-time preparedness of the station
- Training of rescue team
- Outsourcing of ancillary services
- Regular check on the availability of tertiary healthcare services in the region.

- Case Reporting to head office

The **medical officer** supervises the rescue operation from the initiation of departure till the handover of the patient.

Responsibilities:

- Ensure 24x7 readiness for mountain emergency rescue.
- Regularly checklist the drugs and equipment required for medical emergency rescue in the mountains.
- Patient assessment
- Medical intervention and management
- Coordination with EMS station during patient transfer
- Handover of the patient to the doctor at the higher centre, designated by EMS station.
- Case reporting to the station commander

The paramedic and the helper stock up the drugs and equipment from the supplies incharge, and report to the medical officer.

Responsibilities:

- Equip the patient transport vehicle with medical supplies.
- Assist the medical officer during patient management and transfer.
- The helper should also continuously coordinate with the EMS station and be informed about the patient pick-up location and post-transit target health facility.
- Patient monitoring and vital charting
- Medical waste management during patient rescue
- Patient record maintenance during transit

The **supplies and store incharge** should maintain an appropriate supplies management system that facilitates an best level of preparedness and ability to respond to demand during the rescue.

Responsibilities:

- keep a journal entry all the medical consumables and equipment.
- responsible of sanitization and autoclaving of the medical instruments.

The **logistics incharge** must take care of all transport related to patient care and the functioning of the EMS station. As shown in the hierarchy, the driver/pilot and the vehicle maintenance incharge report to the logistics incharge. In the initial phase of the project, if the driver/pilot is skilful in vehicle maintenance, the duties of the river/pilot and vehicle maintenance can be taken up by one person.

Responsibilities:

- transporting patients, medical personnel, pharmaceutical drugs, and healthcare equipment.

The **communications incharge** is responsible for the “SOS” message relaying. It is expected that some “SOS” calls might be received by the head office which need to be relayed at the appropriate EMS station. The communications incharge is responsible for relaying of those calls as well.

Responsibilities:

- disperse the message from the SOS call to the station and commander and each member of the rescue team.

- real-time coordination with helper during rescue for patient status and to convey target healthcare facility.

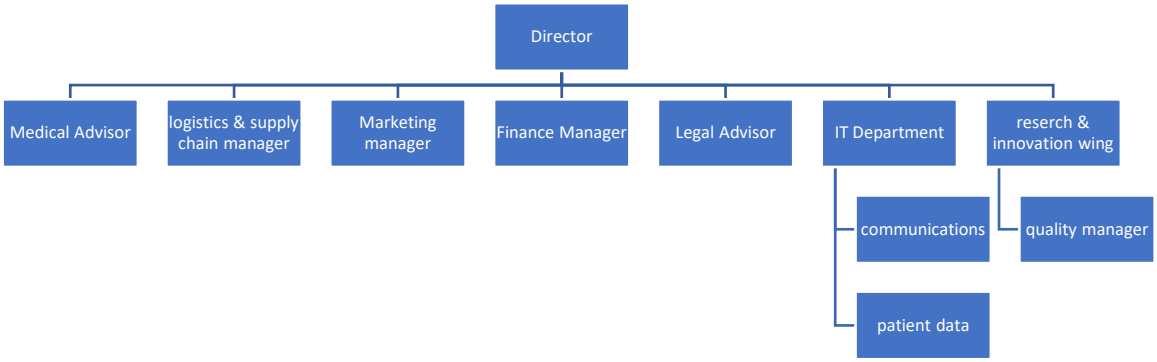
- Contact possible target health facility and get confirmation on patient acceptance.

The **waste disposal incharge** must be well versed with and practice WHO waste management policies, regulations, and procedures. Waste should be collected and segregated into four major categories of general waste, sharp waste, infectious waste, and other hazardous waste.

Responsibilities:

- Biomedical and general waste segregation and appropriate disposal.

At the head office



The head office. The operations at the head office form the backbone of the project and are pivotal for the effectiveness of the active operations. The hierarchy flowchart depicts various passive operations under the supervision and coordination of a project director. In the initial phase of the project, when the emergency case load is less, the staff at the head office can work as interoperable departments with staff members sharing tasks with each other. This method will not only enhance teamwork but also help each departmental head understand the workings of all the operations(35).

The medical advisor will oversee the medical aspect of emergency rescue. His/her responsibility is to assess the pharmaceutical and equipment needs of the rescue teams at the EMS stations. He analyses each rescue, especially in case of death and escalations.

The legal advisor is responsible for the medicolegal aspect. He should be thoroughly informed about the patient transfer regulations of the respective EMS stations.

The logistics and supply chain manager responsible for keeping the EMS station stores stocked up and ensuring the availability of patient transfer vehicles at the EMS stations. with medical supplies, equipment, fuel, stationery, and other consumables. the store tracks the availability and usage of patient transfer vehicles.

The IT department is responsible for two major operations. The communications cell takes care of the SOS calls relaying to the appropriate EMS station. The data management cell is responsible for maintaining the records of each patient rescue case(34).

SPECIFIC COMPONENTS OF PROPOSED INDIAN MOUNTAIN EMERGENCY MEDICAL SERVICES

Communication Management

Communication is critical in delivering emergency medical services, as it enables response and coordination among different responders and healthcare facilities. SOS message is relayed to on station medical team and the driver/pilot via telephone call or wireless radio message. While the medical emergency rescue and management is ongoing away from the EMS station, communication is continuously maintained between the communication incharge at the EMS station and the medical team in the transport vehicle to know the patient's status in real-time and inform the medical team about the target healthcare facility(36). Closed-loop communication, using simple language and use of nonverbal cues such as hand gestures are some skills that are essential for effective

communication in such high-stake situations(14). Using standardized communication tools and technologies, such as radio systems, mobile phones, and computer-aided dispatch systems, to facilitate rapid and accurate information exchange. The availability of a back-up communication system, where cellular coverage is limited, should be considered. High Altitude Platforms (HAPS) can dynamically, and on-demand deploy networks, offering users communication with other cellular and/or fixed networks(41). The patient information should be relayed continuously at regular intervals so that the target healthcare facility is informed and prepared for patient arrival. To monitor a patient's status and vitals, wearable devices with sensors, like AID-N which is developed by Johns Hopkins University, can be brought into use(42).

Transport Management

Getting the patient to the most appropriate healthcare facility is the ultimate objective of every emergency medical service. Transportation of personnel or equipment by land can be time-consuming and potentially dangerous in the treacherous mountain terrain. The most efficient transportation modality is the one which transports the patient quickly and safely to the appropriate healthcare facility for further treatment.

The most widely used transportation modalities to deliver emergency medical services in the mountains are ambulances and helicopters. Ambulances are the most common mode of transportation for emergency medical services, as they are equipped with medical equipment and staffed by trained healthcare providers who can provide care during transport to the hospital. Helicopters are often used where patients need quick transport over long distances or in areas where ground transportation is difficult or impossible(43).

Lately, drones have been successfully utilized during medical rescue operations(44). Drones have assisted rescuers by transporting blood, and locating casualties in dangerous circumstances or remote locations(45). Transportation of automatic external defibrillator

by drone in Sweden where the life was saved is an example of varied scope of use of drones(46). The Indian Institute of Technology Roorkee proposed a vehicle selection and routing model for medical emergencies, after a study in 2018. An experimental vehicle routing and scheduling study was conducted in Uttarakhand. It used an automated decision-making model. The study showed an improvement of 42.1% in vehicle allocation time, 54% improvement in vehicle arrival time, 27.9% improvement in patient transport time, and 62% in total response time(16).

Medical Interventions

The aim of the emergency medical rescue in the mountains is not patient transfer to the health facility. However, the operations also encompass the management of the ailment during patient transfer. The presence of physicians who are experienced in emergency medical care is always beneficial for a better prognosis of the medical emergency. Emergency medical services may require a range of medical interventions depending on the patient's condition and the resources available(40). Some of the most common medical interventions used in emergency medical services are mentioned in Table 2.

Table <2> List of medical interventions during mountain emergency medical rescue.

Medical interventions are impossible without the right drugs and equipment. Most equipment used in mountain emergencies are same as the equipment used in hospital emergency rooms. However, some equipment used in mountain emergency medical services is a bit different to make patient management more efficient(47). For example, using kaolin-based gauze for quicker haemostasis(48). The list of equipment essential for mountain emergency medical rescue is mentioned in Table 3.

Table <3> List of equipment essential for medical interventions during mountain emergency medical rescue.

Supply Chain Management

Supply chain management in Mountain Emergency Medical Services (EMS) refers to the process of planning, sourcing, procuring, storing, and distributing medical supplies, equipment, and pharmaceuticals to ensure that EMS personnel have access to the necessary resources to deliver effective emergency medical care(35). Supply chain management in EMS is critical to ensuring that emergency medical personnel have access to the right resources at the right time. A complete inventory of in-use equipment and consumables should be available. Regular inventory checks should be done to maintain an overview of existing stock, tracking of consumption trends, and maintain an audit trail for inventory management.

Finance Management

Financial management involves the responsible and effective handling of financial resources to support the delivery of high-quality emergency medical care. It encompasses various financial aspects like budgeting, revenue generation, cost control, billing and coding, resource allocation, grants and funding, insurance negotiations, auditing, asset management, financial reporting, and long-term planning(37). Financial management in EMS is executed through careful planning, oversight, and adherence to financial policies and regulations.

Marketing Management

Marketing management in Emergency Medical Services (EMS) is the strategic process of promoting and positioning EMS organizations to the community and informing them that services are available to them. By executing marketing strategies effectively, EMS organizations can establish themselves as reliable and valuable resources in times of need. Marketing management in EMS involves strategies for community engagement, branding, public relations, online presence, advertising, public education, feedback

collection, partnerships, crisis communication, and ongoing assessment to raise awareness, build trust, and ensure the community accesses emergency services efficiently(34).

Personnel Training and Exercises

The training of medical staff, specifically in managing high-altitude medical emergencies, has shown beneficial outcomes. An interventional study was done in Jammu and Kashmir, where doctors and medical staff were trained specifically to manage high-altitude ailments. The high-altitude deaths showed a reduction by 83% in one year(49).

CONCLUSION

A review of emergency medical services from around the world provided an insight into the essential components of a functional EMR system in the mountains. Successful EMR systems are functioning in developed countries like the USA, UK, Canada, Switzerland, etc. There is a lack of well-designed EMR systems in the developing countries.

This paper is an attempt to conduct a scoping review of EMR systems around the world and provide a proposed prototype of EMR in India. The paper proposes a prototype of mountain emergency medical services that can implemented in India. It proposes a services model with two levels of operations: one at the head office and a second at the EMS stations. The core function of patient rescue and transfer will actively be performed team at the EMS station, while the Head office must act as the backbone of all the operations of mountain emergency medical services.

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Annexure

Table 1.

S.No	**Country**	**Studies referred**
1.	USA	1. Ghelichi Z, Gentili M, Mirchandani PB. Logistics for a fleet of drones for medical item delivery: A case study for Louisville, KY. 2. Ettinger S, Long A, Ganti A, Mortimer RB, Chiang W, Spano S. Search and Rescue in the Pacific West States.
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3.	Greece	1. Karani I, Balaskas A, Kaliampakos D. Medical transportation and the contribution of air medical evacuation in isolated mountainous areas of Greece — Case study, Municipality of Agrafa. J Mt Sci. 2022.
4.	Nepal	1. Pandey NR. Emergency medicine in Nepal: present practice and direction for future. Vol. 9, International Journal of

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5.	Bhutan	1. Giri S, Sharma U, Choden J, Diyali KB, Dorji L, Wangchuk C. Bhutan's First Emergency Air Medical Retrieval Service: The First Year of Operations. Air Med J. 2020. 2. Standard Operation Procedure for Bhutan Emergency Aeromedical Retrieval Team 3. Kincaid J, Mize C, Dorji M. Emergency Ambulance Dispatch and Drive Times: An Analysis of Prehospital Vehicular Response in the Kingdom of Bhutan. Prehosp Disaster Med. 2019.

Table 2.

S.no.	Medical intervention	Technical standard
1.	triage	Initial field triage
2.	Assessment, resuscitation and stabilization	Basic resuscitation and stabilization
3.	Referral and transfer	basic stabilization and referral
4.	Wound management	Haemostasis and wound care
5.	burns	Burns first aid, fluid management, pain relief
6.	Fracture management	Immobilization and basic management
7.	Spinal injuries	Assessment, immobilization, and transfer
8.	Reproductive, maternal and newborn care	Basic emergency obstetric and neonatal care
9.	Pain management and anaesthesia	Local anaesthesia and pain control
10.	Surgery and preoperative care	Minor procedures with local anaesthesia
11.	Blood transfusion services	Safe blood transfusion capability
12.	Laboratory services	Basic blood grouping, ABG

13.	Clinical pharmacy and consumables	Outpatient drug supply for declared capacity, including surgical and anaesthetic drugs

Table 3.

S. no.	**Item**	**Purpose**
1.	Stethoscope	Auscultation
2.	Sphygmomanometer	Blood pressure measurement
3.	Pulse Oximeter	Blood oxygen monitoring
4.	Electronic thermometer	Body temperature monitoring
5.	Glucometer with strips	Blood glucose measurement
6.	Normal saline	Fluid supplementation
7.	Ringer's lactate	Fluid supplementation
8.	5% DNS	Fluid supplementation
9.	IV cannula (yellow, blue, pink, green & gray)	IV access
10.	Vented IV lines	Fluid delivery
11.	Syringes	Drug delivery
12.	Portable oxygen cylinder with humidifier and regulator	Oxygenation
13.	Oxygen mask	Oxygenation
	Nebuliser	

14.	Pocket Bag-valve mask (adult, neonate & paediatric)	Respiratory support
15.	Portable suction device with suction catheter	Airway clearance
16.	Guedel airway (adult, neonate & paediatric)	Maintain Airway patency
17.	Laryngoscope (adult, neonate & paediatric)	Endotracheal intubation
18.	Gum-elastic bougie	Endotracheal intubation
19.	Endotracheal tubes	Endotracheal intubation
20.	Decompression needle	Decompress Tension pneumothorax
21.	Philadelphia neck collar	Cervical immobilisation
	Chest compressor	
22.	Tourniquet	Stop bleeding from limbs
23.	Vented chest seal	Lacerated chest injury
24.	Trauma sheers	Cut clothes/dressing and expose body
25.	Haemostatic dressing (multiple sizes)	Haemostasis
26.	Compression bandage	Haemostasis
27.	Triangular bandage	Upper limb immobilisation
28.	Gauze pieces	Wound management
29.	Rolled gauze absorbent	Wound management
30.	Rollable splint	Limb immobilisation
31.	Haemaceal infusion	Blood volume expander
32.	Foley's catheter and bag	Maintain urine output
33.	Ryle's tube	Drug delivery and gastric content aspiration

34.	Hypothermia blanket	Cover the patient
35.	Crepe bandage	Support muscles and joints
36.	Nylon sutures	Wound management
37.	Needle holder	Suturing
38.	Scalpel and blade	Incision and wound management
39.	Fluid pressure cuff	Fluid resuscitation
40.	Cotton role	General patient management
41.	Sterile gloves	General patient management
42.	Alcohol swabs	General patient management
43.	Torch pen	General patient management
44.	Collapsible stretcher	Patient transfer
45.	Portable ECG monitor with leads	Cardiac monitoring
46.	Automatic external defibrillator	Cardiac arrest
47.	Infant incubator	Newborn support system
48.	Wireless radio	Communication while patient transfer
49.	Micropore tape	General patient management
50.	Duct tape	General patient management
51.	Blood grouping kit	Blood grouping
52.	MARCH cards	Patient categorization and triaging
53.	ORS	Electrolyte replacement
54.	Hydrogen peroxide	Wound management
55.	Betadine spray	Wound management
56.	Diclofenac spray	Pain management

57.	Fentanyl pain patch	Pain management
58.	Silver-sulphadiazine	Burn management
59.	Salbutamol respules	Respiratory distress
60.	Inj. & tab. Pheniramine	Antihistaminic
61.	Inj. & tab. Pantoprazole	Antacid
62.	Inj. Ondansetron	Antiemetic
63.	Tab. Domperidone	Antiemetic
64.	Tab. Albendazole	Deworming
65.	Inj. & tab. Paracetamol	Antipyretic
66.	Tab. Amlodipine	Antihypertensive
67.	Tab. Nitroglycerine	Antihypertensive and cardiac emergency management
68.	Tab. Isosorbide dinitrate	Cardiac emergency management
69.	Tab. Metoprolol	Cardiac emergency management
70.	Tab. Clopidogrel	Cardiac emergency management
71.	Tab. Atorvastatin	Cardiac emergency management
72.	Tab. Ecosprin	Cardiac emergency management
73.	Lignocaine jelly	Local anaesthesia
74.	Inj. Lidocaine	Local anaesthesia
75.	Inj. Adrenaline	Cardiac emergency management
76.	Inj. Atropine	Organophosphate Poisoning
77.	Inj. Hydrocortisone	Anaphylactic reaction
78.	Inj. Furosemide	Fluid overload
79.	Inj. Tramadol	Pain management
80.	Inj. Phenytoin	Anti-epileptic

81.	Inj. Midazolam	Sedative
82.	Inj. Mannitol	Reduce intracranial pressure
83.	Anti snake venom	Snakebite management
84.	Inj. Tetanus toxoid	Wound management
85.	Inj. Calcium gluconate	Cardiac arrest
86	Inj. Metoclopramide	Antiemetic
87	Inj. Ketamine	Sedative
88	Inj. Diazepam	Sedative
89	Inj. Adenosine	Cardiac emergency management
90	Tab. Aspirin	Pain management
91	Inj. Naloxone	Opioid poisoning
92	Inj. Tranexamic acid	Haemostasis