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Impact of capacity building training on emergency medical services for chardham yatra: a pre-test post-test study in a hilly region of North India

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Abstract

Background The Char Dham Yatra in Uttarakhand, India, poses significant healthcare challenges due to high altitude, limited medical infrastructure, and increased risk of emergencies, including high-altitude illnesses and cardiovascular events. To address these challenges, a capacity-building program was implemented for medical officers, aiming to enhance their emergency medicine skills.

Method The study was conducted at the Emergency Medicine and Trauma Surgery Department, AIIMS Rishikesh. The study was conducted for 6 months. A total of 150 medical officers were nominated, with 125 participating. The training involved weekly sessions over three months, comprising didactic lectures and hands-on practical skills, particularly in basic life support. Pre and post-tests comprising 20 questions assessed participants' knowledge, and skill assessments were conducted using a 7-item questionnaire on a 5-point Likert scale.

Result The program resulted in a significant improvement in participants' knowledge, with an average increase of 41% in post-test scores compared to pre-test scores ($p < 0.001$). Skill assessment showed that 70.4% of participants were rated as "Outstanding" or "Very Satisfactory." The distribution of trained officers was uneven across districts, with Pauri and Tehri having the highest representation.

Conclusion The capacity-building program significantly enhanced the emergency medicine capabilities of medical officers, leading to better preparedness for handling medical emergencies during the Char Dham Yatra. The positive outcomes highlight the importance of continued investment in such training programs to reduce morbidity and mortality. Addressing the uneven distribution of trained officers is crucial for comprehensive emergency medical coverage along the pilgrimage route.

Keywords Capacity Building, Emergency medical services (EMS), Char Dham Yatra, Medical officer training, High-Altitude illness management

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Introduction

The Char Dham Yatra, an annual pilgrimage to the four sacred shrines of Yamunotri, Gangotri, Kedarnath, and Badrinath in Uttarakhand, India, attracts millions of devotees from across the globe [1]. This influx of pilgrims, particularly during the peak season from April to November, poses significant challenges to the healthcare system in the region. The arduous trek, high altitude, unpredictable weather, and limited medical infrastructure contribute to increased morbidity and mortality among the pilgrims. During this yatra there is not only enhanced risk of high-altitude illness but also non-communicable diseases such as acute coronary syndromes & Stroke. In India, cardiovascular diseases (CVDs) are the leading cause of death and disability, contributing to 31.8% of all deaths and 14.7% of global disability-adjusted life years (DALYs) in 2017 [2]. The data shows an increase in deaths due to cardiovascular diseases, rising from 12.4 million in 1990 to 19.8 million in 2022 [3]. Despite a 34.9% decline in the global age-standardized mortality rate since 1990, ischemic heart disease and stroke remain the predominant causes [4]. In India, CVDs account for 27% of total deaths, with a disproportionately high age-standardized death rate of 272 per 100,000—higher than the global average [5]. The burden of CVDs has increased from 155.7 to 209.1 deaths per 100,000 between 1990 and 2016[6], with significant regional disparities, such as Punjab having nine times the ischemic heart disease burden compared to Mizoram [6].

Emergency medical services in Uttarakhand, particularly during the Char Dham Yatra, are critical due to the geographical and climatic adversities of the region. The doctors, who are at the frontline of providing emergency care, handle altitude-related illnesses and other medical emergencies such as acute coronary syndrome, acute shortness of breath, trauma related emergencies, stroke and mass casualty situations, as well as insufficient resources and logistical support [7]. The Char Dham Yatra faces challenges similar to rural healthcare, including remote locations, inadequate facilities, financial constraints, and limited awareness of altitude-related illnesses. Elderly pilgrims often depend on family, causing delays in seeking care, while cultural beliefs and psychosocial factors further hinder timely medical intervention. Improved infrastructure, awareness, and support are essential to address these issues [8].

The high-altitude environment of the Char Dham Yatra presents unique health challenges such as acute mountain sickness (AMS), high-altitude pulmonary edema (HAPE), and high-altitude cerebral edema (HACE), which require specialized knowledge and skills for effective management. Acute Mountain Sickness (AMS) typically occurs at elevations above 2,500 m (8,200 feet). However, susceptibility varies among individuals, and symptoms can manifest at lower altitudes in some cases. Factors such as the rate of ascent, individual acclimatization, and pre-existing health conditions influence the onset and severity of AMS [9].

General emergency care focuses on acute conditions such as cardiac arrest and stroke, using protocols like CPR and advanced life support. The key distinction lies in altitude-specific pathophysiology versus systemic emergencies, requiring an integrated approach in high-altitude healthcare. Thus, capacity building in primary management of such illnesses is pivotal for several reasons. Most of these emergencies require timely identification, intervention and referral to appropriate centre of choice. The patient should receive immediate initial stabilization in the form of maintenance of airway, breathing, circulation, disability assessment and exposure. By training the front-line workers about the maintenance of vital signs and timely referral can prevent significant mortality and morbidity.

Studies have highlighted that proper training in altitude medicine can significantly reduce the incidence and severity of these conditions [10]. Strengthening the capacity of these medical officers through targeted training programs and infrastructure development is essential to improve the quality and efficiency of emergency care during the Yatra. Therefore, this study aimed to evaluate the effectiveness of a comprehensive capacity-building program for medical officers involved in the Char Dham Yatra. This initiative is expected to not only reduce morbidity and mortality rates but also enhance the resilience of the healthcare system in Uttarakhand.

Methodology

The study was carried out at the Emergency Medicine and Trauma Surgery Department, AIIMS Rishikesh. The study was conducted for a period of 6 months, i.e. January 2024 to June 2024. The medical officers posted in various Primary Health Centre /Community Health Care in Uttarakhand were nominated by the Director General Health Services of the state.

Medical officers were chosen for this training as they serve as frontline healthcare providers in Uttarakhand's remote and high-altitude regions. Their role in managing emergencies and providing timely stabilization and referral is critical, especially during the Char Dham Yatra, where advanced medical infrastructure is limited. Training them ensured a strengthened emergency response at the primary healthcare level.

This training included once a week training session of batch of 25 Participants including lectures using a mixed methodology of didactic slide presentations, and hands-on sessions focusing on fundamental lifesaving skills, conducted by the trained faculties of the Emergency Medicine department. Each session accommodated a

different batch of participants. This ensured no repetition among attendees and allowed the training program to cater to a larger group of medical officers effectively and ensured that the training was consistent and manageable for all involved, while maintaining the quality of instruction and hands-on practice Box 1 shows the didactic topics that were covered in the training along with hands-on training on BLS. The training modules were designed considering the specific healthcare challenges in Uttarakhand, such as managing emergencies in remote, high-altitude regions with limited resources. These modules emphasized the timely identification and stabilization of critical conditions, patient referral pathways, and practical skills tailored to the local healthcare infrastructure. A booklet compiled of the 9 training modules was provided to all participants before the training sessions. The booklet content was standardized as per established guidelines, covering essential topics such as managing high-altitude illnesses (e.g., AMS, HAPE, HACE) and other critical emergencies. The booklet was provided to serve as a future reference for participants, enabling them to manage similar cases effectively in real-world scenarios. This approach ensured both pre-training preparedness and long-term utility for decision-making in emergency care.

The 9 lecture module series was followed by hands-on-training. Skill assessment was done through the skill assessment module at the simulation laboratory, AIIMS Rishikesh. Post-assessment was done after the training. The training was based on standard guidelines and practices. Pre and Post test questions were prepared separately for each batch. Each test included 20 questions about Emergency Medicine. The pre- and post-test questionnaires were developed following standard guidelines and validated by external experts in emergency medicine. The validation process included a review of the content for relevance, clarity, and alignment with the training objectives, ensuring that the questions accurately assessed the participants' knowledge and skills in managing medical emergencies. The questionnaire focused on clinical approaches to managing various conditions, including shortness of breath, chest pain, stroke, hypertension, and seizures. It also addressed specialized scenarios such as diabetic ketoacidosis, hyperosmolar hyperglycaemic state, high altitude sickness, abdominal pain, and acute gastroenteritis, emphasizing systematic evaluation and treatment strategies for these conditions.

A paired sample t-test was employed to analyse the pre-test and post-test scores. Skill assessment test was done after each skill station for each Medical Officer. The skill was evaluated using a 7-item questionnaire employing a 5-point Likert scale (Box 2). The scale ranged from 1 to 5, with the following designations: 1 = Poor, 2 = Unsatisfactory, 3 = Satisfactory, 4 = Very Satisfactory, and 5 = Outstanding. Knowledge and attitude were assessed using standardized questionnaire and skill was assessed at skill station in a protocolized manner.

Inclusion criteria

Medical officers posted at PHCs and CHCs in Uttarakhand were included to ensure participation of frontline healthcare providers directly responsible for managing emergencies during the Char Dham Yatra.

Exclusion criteria

Medical officers unwilling or unavailable to participate were excluded to ensure engagement and adherence to the training schedule.

Result

A total number of 150 medical officers were nominated for the training out of which only 125 medical officers participated in the training. All the participants completed the entire training. The geographical distribution of participants across districts is shown in Fig. 1. Pauri had the highest representation with 25 participants (20%), followed by Tehri with 20 participants (16%), and both Almora and Nainital with 17 participants each (13.6%). On the lower end, Bageshwar had only 1 participant (0.8%), and Dehradun had 2 participants (1.6%). This indicates that most participants were concentrated in a few districts, particularly Pauri and Tehri, which together made up 36% of the total sample.

Overall, the training produced positive results. A comparison between the post-training and pre-training assessments showed a significant increase in participants' knowledge because of the training. On average, participants in emergency medicine experienced a 41% improvement in knowledge when comparing the pre- and post-training assessments.

The paired samples statistics show a significant improvement from pre-test to post-test scores among 125 participants. The pre-test mean was 10.61 ± 3.672, and the post-test mean increased to 14.82 ± 2.628. These results suggest that the intervention was effective in significantly enhancing participants' performance. The mean difference was -4.216 ± 2.378, with a 95% confidence interval from -4.637 to -3.795. The t-value was -19.822, and the p-value was < 0.001. The results indicate a statistically significant effect of the intervention, suggesting its potential effectiveness in improving participants' performance.

A total of 125 participants underwent skill assessment. As illustrated in Fig. 2 the results indicated that 51 participants (40.8%) achieved an Outstanding rating, while 37 participants (29.6%) were classified as Very Satisfactory. Additionally, 23 participants (18.4%) were rated as Satisfactory, and 14 participants (11.2%) were deemed

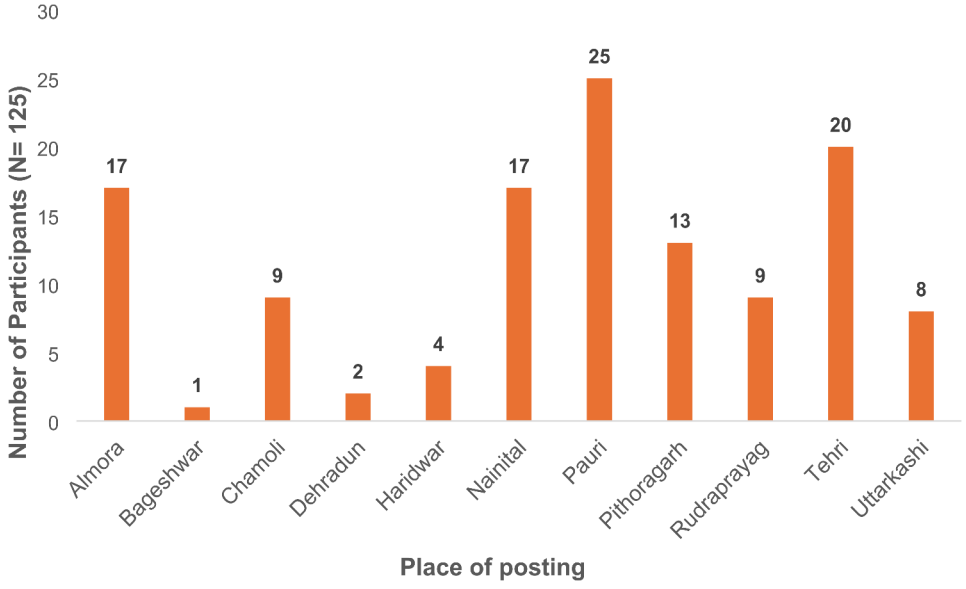

Fig. 1 District-wise distribution of training participants

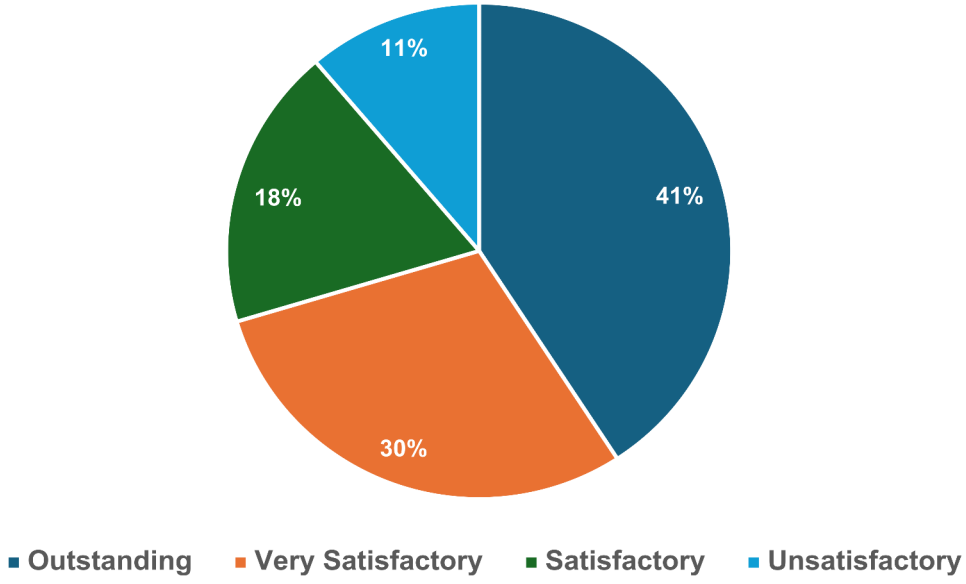

Fig. 2 Skill assessment results of training participants

Unsatisfactory. "Unsatisfactory" rating on the skill assessment was attributed to the limited time available for hands-on practice during the training, as mastering technical skills like CPR, airway management, and team coordination often requires repetitive practice. Individual differences in confidence levels and stress handling during the skill assessments may have contributed to these ratings.

Discussion

This study emphasizes the effectiveness of the training program in significantly enhancing the emergency medicine knowledge of medical officers. The results reveal a substantial improvement in participants' performance from pre-test to post-test, indicating the program's positive impact. Comparison of this study with a similar capacity building study done at Ukraine demonstrated significant improvements in emergency care knowledge and skills among healthcare providers after participating in targeted training programs. The current study showed a substantial increase in mean scores from 10.61 in the pre-test to 14.82 in the post-test, while the Ukraine study reported an improvement in median scores from 19 to 22 on a 25-point scale [11]. This consistency across different geographical and healthcare contexts points out to

the effectiveness of structured emergency care training in enhancing provider competencies.

The statistical significance of the improvements in both studies ($p < 0.001$ in this study and in the overall analysis of the Ukraine study) provides robust evidence for the positive impact of such training initiatives. This suggests that well-designed emergency care courses can yield measurable and meaningful results across diverse settings, from rural India to conflict-affected regions in Eastern Europe. A study conducted in Saudi Arabia on central venous catheter (CVC) placement involved 25 residents, utilizing simulation-based training. Participants' mean scores improved significantly from 8 to 26, with a p-value < 0.05. Those with prior experience in central line placement scored higher post-training (27) compared to novices (25), though the latter group exhibited a larger improvement. The training effectively enhanced technical skills, though increases in self-confidence did not reach statistical significance [12].

Similarly, the WHO BEC study conducted at sub–Saharan Africa reported significant improvements in post-course exam scores across all three pilot countries. In Tanzania, mean scores increased from 54 to 79% ($p < 0.001$), in Uganda from 65 to 85% ($p < 0.001$), and in Zambia from 64 to 86% ($p < 0.001$) [13].

A pre-post-test study was conducted at united states on ultrasound guided breast biopsy. The ultrasound-guided breast biopsy training demonstrated a substantial improvement in technical skills, with mean scores increasing from 2.44 to 7.10 ($p < 0.001$). These results underscore the effectiveness of targeted training interventions in enhancing healthcare providers' competencies [14].

Real-time health data analysis, as demonstrated in the COVID-19 surveillance system in Kashmir, can significantly enhance epidemic prevention and emergency care during large events like the Char Dham Yatra [15]. Continuous monitoring of health indicators allows for timely interventions, improved resource allocation, and better coordination among healthcare teams, strengthening emergency preparedness in high-risk regions.

The training program significantly improved participants' knowledge and skills, but several barriers could affect its sustainability. Uneven participant distribution across districts leaves some areas underserved, while limited infrastructure, logistical challenges, hinder effective implementation. The lack of follow-up assessments to measure long-term impact and the absence of real-time feedback further weaken the program's scalability. Medical officers during the Char Dham Yatra face challenges including managing high-altitude illnesses in resource-limited settings, harsh environmental conditions, and overcrowded healthcare facilities. Limited medical supplies, communication barriers with diverse pilgrims, logistical issues in patient evacuation, and handling mass casualty incidents further impact care delivery. Stress from long working hours and demanding conditions also poses significant challenges. Challenges in Uttarakhand, such as high-altitude conditions and remote locations, differ from regions such as Saudi Arabia or sub-Saharan Africa, where better infrastructure and fewer communication barriers facilitate easier implementation of emergency care programs. Understanding these differences can provide insights into the scalability of emergency care programs across diverse settings.

Conclusion

This study highlights the significant positive impact of a capacity-building program on enhancing the knowledge and skills of Medical Officers during the Chardham Yatra in Uttarakhand. The results align with similar global studies, demonstrating the effectiveness of structured emergency care training in diverse healthcare settings. Future studies should focus on assessing the long-term outcomes of capacity-building programs to evaluate their sustained impact on EMS effectiveness. Research should also explore strategies to ensure uniform EMS training across diverse geographies, addressing disparities in healthcare infrastructure and resources. Implementing standardized training modules tailored to local challenges could further enhance the consistency and quality of emergency care delivery.

The training program significantly improved participants' knowledge and skills, but few barriers could affect its sustainability such as limited infrastructure, Geographical difficulties, uneven doctor to patient ratio and the varied participation of doctors across the state which was decided by the state health authorities based on merit and previous experience. Addressing these challenges through equitable distribution, sustainable funding, improved infrastructure, and follow-up strategies is essential to ensuring comprehensive emergency medical care during the Char Dham Yatra.

This study offers strong evidence for the value of investing in capacity-building initiatives for medical officers involved in high-risk events, serving as a model for similar challenges in other regions. The program's success indicates its potential to reduce morbidity and mortality during the Yatra, emphasizing the need for continued investment in healthcare capacity building and the expansion of such programs.

Supplementary Information

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Supplementary Material 1

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Author contributions
NK & MU designed the study & reviewed the Manuscript. SP Analysed the data & wrote the manuscript. AC & PK collected data. JS & MM delivered the lectures to the participants. PSM coordinated the validation of Data collection Tool.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval
The study protocol was reviewed and approved (letter no- AIIMS/IEC/24/162) by the Institutional Ethics Committee of AIIMS Rishikesh on 08/04/2024.

Consent to participate
Informed consent was obtained from all participants prior to their inclusion in the study and participants confidentiality was strictly maintained.

Consent for publication
Not Applicable.

Competing interests
The authors declare no competing interests.

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