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Original Research Article

Effectiveness of Hapo Chamber Ventilation on Acute High Altitude Sickness: An Observational Study

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Abstract

Background: To assess the role of non-pharmacological method (one man HAPO chamber ventilation) in the treatment of High Altitude Sickness (HAS) for a period until descent of patient.

Method: The study region was Panchtarni base camp of Shri Amarnath Yatra-2016. Patients were come for medical assistance for different of complains at Panchtarni base camp hospital. They were assessed for symptoms and signs of High Altitude Sicknesses [AMS (Acute Mountain Sickness)/HACE (High Altitude Cerebral Edema)/HAPE (High Altitude Pulmonary Edema)] according to LAKE LOUISE SCORING SYSTEM. One man HAPO chamber ventilation (HCV) were used for 32 patients with moderate-severe AMS, HACE and HAPE after medical treatment. Pre and post-HCV Parameters (Vitals, SPO2, Lake Louise Score) were recorded and analysis was done.

Result: The clinical score, Lake Louise Score, which is the morbidity indicator of High altitude sickness was significantly reduced (Mean difference 3.97, 95%CI 3.45-4.48) after one man chamber HAPO ventilation along with significant improvement in SPO2 and vitals.

Conclusion: Inadequate acclimatization remains the most significant risk factor for developing HAS. Clinicians advising individuals, who are preparing to travel to high altitude, should provide education about the importance of slow graded ascent. Immediate descent and administration of supplemental oxygen to raise saturation levels above 90% continue to be the definitive treatments for HAS. The use of portable hyperbaric chamber may be an effective temporizing measure along with Nifedipine, Dexamethasone and/or Acetazolamide as an adjunctive treatment.

Keywords: High Altitude Sickness, Acute Mountain Sickness, HAPO Chamber Ventilation, One-Man HAPO Chamber.

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Introduction

Every year around 5 lakh pilgrims visited to the cave shrine of Shri Amarnath Ji Annual Pilgrimage (Yatra) (a holy ritual among the Hindu devotees of Lord Shiva). The cave is situated at height of 3882 m [1,2].

HAS can occur at height over 2500 m due to the decreasing partial pressure of oxygen at such altitude. This can be best avoided by slow adaptation to the altitude (acclimatization).

Mildest form of HAS is acute mountain sickness (AMS) which is mainly characterized by subjective symptoms (headache, loss of appetite, insomnia, weakness, nausea and rarely also vomiting). Symptom of AMS are known to generally occur within 6-12 hours of acute ascent to > 2500 m and most of these symptoms subside within 1-2 days if appropriate preventive measures are taken [3]. Advanced and life threatening form of HAS are characterized by tissue edema- cerebral or pulmonary high altitude edema which are associated with high mortality. These are much less common than AMS, with incidences of approximately 0.1 to 4% (11). The common denominator of these acute forms is the hypobaric hypoxemia and tissue ischemia. The only causal therapeutic intervention is to restore adequate oxygen tension, descent to lower altitude or oxygen therapy. All forms of HAS can be countered by a rapid descent to a height of at least 500 m [4,5].

Method:

Study was conducted at Panchtarni base camp hospital. Patients, who had come for medical assistance, were assessed clinically. Baseline vitals (Pulse rate, Respiratory rate, Blood pressure) and SPO2 were recorded. Pulse oximeter was used for recording SPO2 after proper warming of hands. Oxygen saturation is a good supporting indicator of HAPE [6].

Diagnosis of HAS (AMS/HACE/HAPE) were made on the basis of LAKE LOUISE SCORING SYSTEM [7]. All patients of HAS were given medical treatment (Oxygenation, Acetazolamide, Nifedipine and/or Dexamethasone) followed which patients with moderate-severe AMS, HACE and HAPE were treated with ONE MAN HAPO CHAMBER ventilation for at least 1 hour according to protocol. Pre and post-HAPO Chamber Ventilation vitals, SPO2 and Lake Louise Score were recorded. Data were analyzed with Statistical software using Paired t-test. Informed consent was obtained from all the patients. ONE MAN HAPO CHAMBER (Figure 1.) is a portable first aid device used for treating varying degree of HAS. The most effective treatment for HAS is to move the patient to lower altitude, which is often not practical, especially at the forward post, due to non-availability of aircraft or hostile weather condition. HAPO chamber which is a light weight (5 kg) cylindrical one man chamber run on the principle of increasing the atmospheric pressure around the patient thereby simulating descent in altitude.

The patient is kept inside the chamber after explaining all the instructions to follow and chamber can be inflated to a maximum pressure of 130 mm Hg thereby simulating a descent of about 2500 m without any physical movement. The principle feature is the APC unit, which when connected to AC power supply, it maintains the pressure between 110 mm Hg to 130 mm Hg [8].

Figure 1: One Man HAPO Chamber Unit and in use.

Result

Mean age of 32 patients observed in the study were 42.81 years (SD 9.89). Mean duration of HAPO chamber ventilation were 72.96 minutes with SD 22.99. The clinical score (Lake Louise Score) decreased significantly after HAPO chamber ventilation, mean 4.88; SD 1.56 ($P < 0.05$). At the end of HAPO chamber ventilation mean SPO2 was 89.72%; SD 3.89, which was improved significantly ($p < 0.05$). Vitals (pulse rate, respiratory rate, systolic blood pressure and diastolic blood pressure) were also significantly improved after HAPO chamber ventilation ($p < 0.05$). Table 1. During the HAPO chamber ventilation all the patients were comfortable and symptomatically improved (Figure 2.) except one

patient for whom ventilation was interrupted within 15 minutes due to restlessness and claustrophobia.

Table 1: Mean changes in parameters pre and post- HCV (HAPO Chamber Ventilation).

Variables	Pre-HCV Mean (SD)	Post-HCV Mean (SD)	Mean difference (95% CI)	Z value	P- Value
Lake Louise score	8.84 (1.82)	4.88 (1.56)	3.97 (3.45 to 4.48)	5.67	<0.05
SPO2 (%)	64.25 (9.29)	89.72 (3.89)	-25.47 (-29.26 to -21.68)	14.03	<0.05
PR (/min)	122.31 (12.15)	85.50 (9.91)	36.81 (31.49 to 42.13	13.28	<0.05
SBP (mmHg)	140.13 (12.88)	126.56 (8.50)	13.56 (10.02 to 17.10)	4.97	<0.05
DBP (mmHg)	94.06 (7.80)	83.78 (5.25)	10.28 (7.69 to 12.88)	6.08	<0.05
RR (/min)	25.84 (4.50)	19.22 (1.93)	6.63 (5.10 to 8.15)	7.65	<0.05

Figure 2: A patient before and during HAPO CHAMBER VENTILATION.

Discussion

Modern method of transportation facilitate a rapid gain in altitude for non-acclimatized low land dweller, who are often forced into tight time schedules that do not allow sufficient time for acclimatization. This the main reason why many tourists develop the unpleasant symptoms of AMS [9]. In a study of Mount Kilimanjaro trek, 70% of trekkers experienced at least one instance of a symptom related to HAS (headache, nausea, vomiting, diarrhea, or loss of appetite) during the trek above 3000m [10].

Risk factors for altitude illness include rapid ascent, strenuous physical exertion, young age, living at a low altitude, and a history of altitude illness [11-15]. Rapid ascent is the most important and modifiable risk factor [12,16-18].

The general rule of thumb for person at altitudes higher than 3000 m is not to sleep more than 300 to 600 m above the previous night's elevation [14]. While in our study patients were come from Baltal base camp (2743m) by air and from Pahalgaam base camp (2740m) by horse/walk, most of them slept only for 6-8 hours of the same night of reaching there and reached in early morning to Panchatarni base camp (3657m) [2].

Descent is mandatory in persons with high altitude cerebral or pulmonary edema. Descent of 300m may be all that is required [11,14]. If descent is not possible, supplemental oxygen, rest, and placement in a portable hyperbaric oxygen chamber may stabilize patients [11,14,15,19,20,21,22]. Rapid relief of symptoms of AMS and HACE or HAPE has been reported by investigators using these portable hyperbaric chambers [23,24,25]. Early mechanical ventilation improve the oxygenation and also reduced pulmonary hypertension and increased cardiac output [26].

Portable hyperbaric chamber or one man HAPO chambers are fairly light weight and are typically carried by high-altitude rescue teams. They may be used on major expeditions, and are often available at rescue stations [15].

In our study we used HAPO chamber ventilation, to the patients who fulfill the diagnostic criteria of mod-severe AMS/HACE/HAPE, for a period of 1 to 11/2 hours by which time medical treatment came in effect [27,28], as the medical treatment and hyperbaric chamber may be used for immediate as well as prolonged relief of HAS [28].

Dexamethasone should be given until descent is possible and until symptoms have resolved [15]. We kept the patients in HAPO chamber for maximum 11/2 hour followed which we asked the patients to descent to lower altitude for further relief, as no long duration benefit were noted previously [28,29,30].

Additional studies about the one man HAPO chamber are needed to determine optimal duration and frequency necessary to obtain sustained improvement. We recommend that one man HAPO chamber must be used only to facilitate but not to delay descent when illness occurs at high altitude.

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