

# Transport of High Acuity HBOT Patients

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## Problem Statement

Hyperbaric oxygen therapy is the primary treatment for several emergency indications including arterial gas embolism, decompression sickness, and acute carbon monoxide poisoning<sup>1</sup>. These indications have high risks of mortality, and thus require immediate treatment. Though hyperbaric centers are proliferating across the US, relatively few centers are capable of treating emergency indications. This necessitates the transport of patients to proper facilities, posing them with physiological risks.

## Materials/Methods

Using the UHMS Hyperbaric Chamber Directory, 43 California hyperbaric centers were located. The survey assessed chamber readiness to respond to emergency indications. Criteria included ability to treat patients requiring ventilators or intravenous drug infusion, availability of 24 hour on-call staff, and treatment of arterial gas embolism, decompression sickness, and carbon monoxide poisoning cases within the last year. Survey methodology is summarized in Figure 1. Results of the survey determined how many centers had the capacity to treat emergencies.

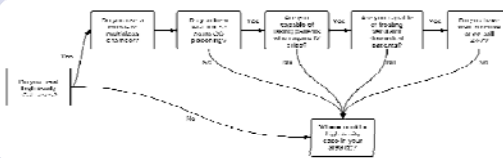


Figure 1: Survey Methodology

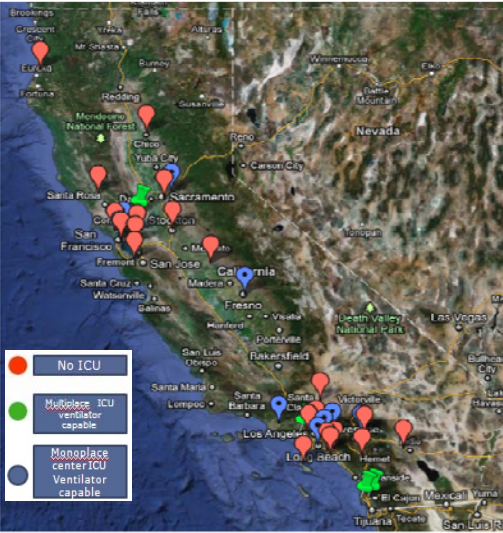


Figure 3: Map of Contacted California Centers

## Results

Of the 43 centers located, 34 were successfully contacted and surveyed. Results are summarized in Table 1 and Figure 2. 8 (23.5%) centers were multiplace, and 26 (76.5%) were monoplace. 18 centers (52.9%) stated that they had the capacity to treat ICU cases, 13 of which were monoplace and 5 of which were multiplace. Of those 18 centers, 7 monoplace and 1 multiplace responded that they were unable to treat ventilator-dependent patients or those requiring IV drug infusion. In total, 6 of 26 monoplace (23.1%) and 4 of 8 multiplace (50%) met criteria (IV pump/ventilator capabilities, 24 hour on call staff) for an emergency-ready chamber. Chamber locations are summarized in Figure 3.

	n
Multiplace centers in California	8
Monoplace centers in California	26
Centers that responded yes to being able to treat ICU cases	18
Monoplace centers that responded yes to being able to treat ICU Cases	13
Multiplace centers that treat ICU cases	5
Monoplace center that stated yes to being able to treat ICU cases but stated that they don't have IV Pumps or Ventilators and rarely see ICU cases	7
Multiplace centers that stated yes to being able to treat ICU cases but stated that they don't have IV pumps or Ventilators and rarely see ICU cases	1

Table 1: Survey Results

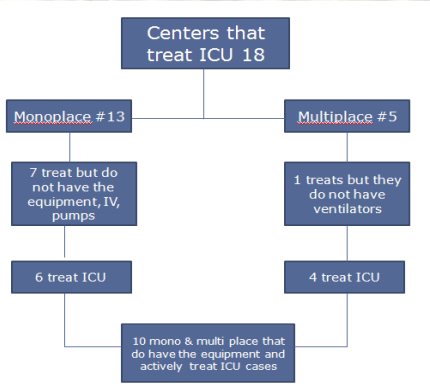


Figure 2: Results Summary

## Risk of Transport

Transportation by helicopter presents numerous risks to the patient including physiological issues, vehicular crashes, and delayed treatment.

Hypoxia may occur as the drop in partial pressure of oxygen at higher altitude leads to a decrease in oxygen saturation of the blood. Decrease in oxygen saturation then causes increase in cardiac output leading to a decrease in ischemic threshold and higher risk of atrial arrhythmias. Expansion of gases also occurs at altitude. Gas trapped in closed space will expand by approximately 35% when going from sea level to 8,000 feet of altitude. This can present complications with patients specifically experiencing gas emboli. Furthermore, nervousness about flight may provoke cardiac ischemia. Physical movement of patient can cause complications ranging from pulling out an IV line to pulling out an endotracheal tube. Risk of transport increases with amount of instrumentation patient is using. Critical care patients are therefore at greatest risk of a complication during transfer.<sup>2</sup>

Helicopter transport also introduces the risk of crashing. Between January 1, 1983 and April 30, 2005 (22.3 years) 182 crashes occurred in the United States. 39% were fatal with the death of 184 occupants. Of these deaths, 45% were patients and 32% were crewmembers. Risk of crashing is seen to increase with conditions such as darkness, bad weather, or low visibility.<sup>3</sup>

Transportation of patients leads to a delay in treatment, which introduces novel risks. For patients with gas embolisms, treatment delay may cause initially reversible damage to become permanent. In a study of 86 patients admitted to Salvator University Hospital of Marseille, France for iatrogenic cerebral air embolism, patients treated with HBOT less than 6 hours after AGE had a recovery rate of 68% while those treated in 6 hours or later only had a 40% recovery rate. After a delay of 24 hours or more, treatment may become ineffective and symptoms may not respond to treatment. Delay in treatment also carries the risk of patient death<sup>4</sup>. Patients with acute carbon monoxide (CO) poisoning have a higher risk of gait and motor disturbances, hearing loss and vestibular abnormalities, dementia and psychosis, peripheral neuropathy, and cognitive sequelae which may become permanent. Delay of treatment also places the patient at risk of death.<sup>5</sup>

## Conclusion

The low availability of emergency-ready centers necessitates patient transport to capable facilities. Additionally, the majority of emergency-ready centers are clustered around a few select areas. Though these areas are some of the most population-dense in the state (Figure 4), center proximity increases the distance from some more remote parts of the state to an emergency-ready center. Transportation of patients comes with various risks depending on the mode of transportation. Risks include hypoxia, expansion of gases, anxiety, and vehicle crashes. Transport also delays hyperbaric treatment which can cause therapy to be less effective and increase risk of residual symptoms and fatality. To reduce the need for inter-facility transport of emergency cases, existing centers must be incentivized to become capable of treating these patients.

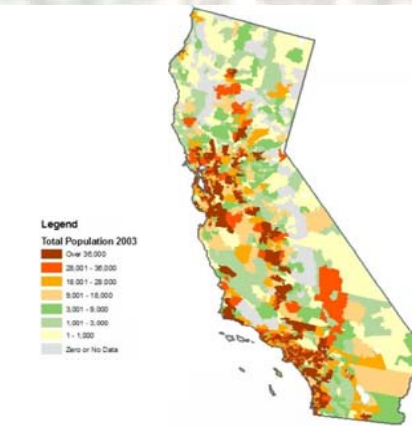


Figure 4: Population Density

## References

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