

We reviewed checklist adherence and treatment outcomes for a one-year period.

Results: Review of our data revealed 100% (N=225) adherence to checklist completion by all team members, though 40% (N=90) were missing one of four signatures. After implementation, we were able to start treatments an average of 14 minutes earlier (32 minutes vs. 46 minutes). Only one instance of variation in care was noted over the year after checklist implementation. In subsequent informal interviews, all staff noted that improvements had been made in teamwork, quality and safety through the checklist process, thereafter prompting ongoing checklist review as part of our internal quality assurance.

Conclusions: By delineating clear roles and responsibilities, a uniform safety checklist can improve the consistency, efficiency and safety of emergent hyperbaric medical care.

E 3

Hyperbaric oxygen therapy prepayment audit: discrepancies between Noridian reviewers and the community standard of care

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Introduction/Background: The U.S. federal government has identified a high incidence of fraud and abuse in the practice of hyperbaric oxygen (HBO₂) therapy. From January 2015 to September 2016, Noridian, a Medicare Administrative Contractor (MAC), conducted a prepayment review of HBO₂ provided at the UCLA Medical Center.

Methods: A database was created to analyze the review findings. Denial reasons were evaluated to build appeal cases, with additional medical records, supporting literature and rebuttal letter from the treating physician(s). An inter-departmental workflow was established to standardize the appeal process, and a Kaizen event identified workflow opportunities to improve clinical documentation.

Results: Up to 78% of claims submitted to Medicare were reviewed. In 58% of total denied claims, reviewers required bone biopsy, culture, MRI or X-ray to confirm diagnoses like osteomyelitis. However, community standard is to accept exposed bone with a high index of clinical suspicion by the treating physician. For many diagnoses in addition to diabetic foot ulcers (DFU), reviewers required 30 days of

no measurable improvement (31%) prior to HBO₂. After the second appeal, MAC reviewers frequently overturned these cases, confirming these criteria apply only to DFU. Similarly, osteoradionecrosis denials citing lack of exposed bone (20%) were overturned after second appeal when it was indicated that a CT scan sufficiently demonstrated osteoradionecrosis. Claims for soft-tissue radionecrosis and osteoradionecrosis were denied if dental surgery was planned (9%), but usually reversed by explaining they are indications nonetheless.

There were often discrepancies between the community standard of care and Noridian's initial denial reasons. The likelihood of overturn was four times higher after the second appeal than the first.

Discussion: Healthcare providers should work with policy-makers to help devise legislation that would grant protection for patients and providers undergoing prepayment review so as to minimize financial burden on individuals and impact on quality of patient care.

E 4

Performance of the Uni-Vent Eagle™ Model 754 ventilator under hyperbaric conditions

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Introduction/Background: Occasionally, critically ill patients requiring mechanical ventilation also require hyperbaric oxygen (HBO₂) therapy. Though ventilators designed for HBO₂ are now commercially available, some institutions use ventilators that were available prior to the advent of these hyperbaric specific units. One such ventilator is the Uni-Vent™ model 754, which has been shown to be an adequate replacement in HBO₂ for non-electric ventilators. However, its performance could benefit from more complete characterization, along with investigation of concerns of oxygen leaks in the vent housing, which poses a fire risk.

Materials/Methods: A Uni-Vent™ Eagle model 754 was investigated at 1.0, 2.4, and 2.8 ATA in assist-control mode using a Michigan Instruments test lung (compliance set to 0.05 L/cmH₂O) and 100% O₂. Tidal volumes ranged from 100-700mL, in 100mL increments for one minute intervals. Delivered volumes, peak pressures and the oxygen percent within the chamber and within the ventilator (using a custom drilled port) were recorded. At each depth, three different respiratory rates were investigated (12, 20 and 30 breaths/

minute). The I:E ratio at 12 and 20 br/min was held to 1:2, while at 30 br/min it was held to 1:1.

Results: At 2.4 and 2.8 ATA, the ventilator delivered a lower volume than at 1.0 ATA. At the respiratory rate of 30 br/min, however, breath-stacking was seen above 300 mL at all depths but was blunted at both 2.4 and 2.8 ATA. Peak pressures increased with both respiratory rate and breath stacking at depth. O₂ levels did not rise in the housing during our investigation.

Summary/Conclusions: Hyperbaric conditions cause decreased delivered tidal volumes in a dose-dependent fashion. Peak pressures increased with respiratory rate, which was blunted at depth except with breath stacking. The Uni-Vent™ Eagle model 754 performed safely and effectively at depth but requires spirometric analysis to correctly program desired ventilator settings.

E 5

The effect of compression rate and slope on the incidence of Eustachian tube dysfunction and middle ear barotrauma: a phase I prospective quasi-experimental study

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Introduction: Eustachian tube dysfunction (ETD) and middle ear barotrauma (MEB) are the most reported complications during hyperbaric oxygen treatment. Despite this, there is no standardized rate of compression (ROC) shown to decrease its occurrence. The incidence shows significant variation across various prospective and retrospective studies. Teaching appropriate ear equalization techniques and concomitant patient disease may play a role in successful or unsuccessful compression. Certain data show the ROC might influence ETD and MEB. Our study was formulated in an attempt to find an optimal ROC that might reduce ETD and MEB.

Methods: Data were collected prospectively on 2,807 patient treatments. We randomly assigned four different ROCs using two variables – time (10 vs. 15 minutes) and slope (linear vs. non-linear) – in a repetitive and consecutive protocol throughout the study period. We recorded any patient or

inside observer (IO) requiring a stop during compression. Patients requiring stops were evaluated post-treatment for the presence of ETD, MEB or both. All findings were compared to our standard 10-minute linear ROC (reference). Otoloscopic findings were graded using both the TEED and O'Neill grading systems for ETD and MEB. The evaluation of the tympanic membrane was accomplished with video otoscopy to capture baseline photos and repeated to evaluate any patient requiring a stop. Data were analyzed using basic statistical methods.

Results: When comparing the different rates of compression, there was a decreased tendency for ETD and MEB in patients compressed using a 15-minute linear schedule. Results are statistically significant.

Conclusion: The use of a 15-minute linear compression schedule is associated with a reduced risk for ETD and MEB during elective hyperbaric oxygen treatments in a Class A chamber.

E 6

Critical thinking inside the box: establishing best practice in the hyperbaric medicine clinic through in situ simulation

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Introduction/Background: What team actions are essential in response to a patient discovered to be in cardiac arrest at 2.0 ATA? How are these actions coordinated among multi-disciplinary team members, separated by undefinable physical laws? What actions may or may not be performed by the inside attendant during the 90 seconds required for the multiplace hyperbaric chamber to rapidly decompress? How do we understand best practice management of cardiac arrest in the hyperbaric medicine clinic?

Hyperbaric oxygen (HBO₂) therapy is administered in a pressurized environment that imposes limitations on conventional life support response. HBO₂ team members must think critically and prioritize interventions that optimize patient survival and minimize the potential for pressure-related injury to staff.

Materials/Methods: A multidisciplinary simulation exercise, supported in situ by the simulation center of this large tertiary academic medical center in the Midwest, afforded