Sudden Sensorineural Hearing Loss

Dick Clarke, CHT

Sudden Sensorineural Hearing Loss

Primary Training in Hyperbaric Medicine

Columbia, South Carolina

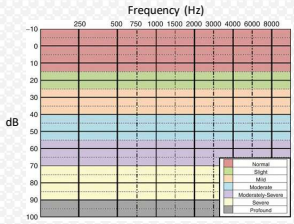
Definition

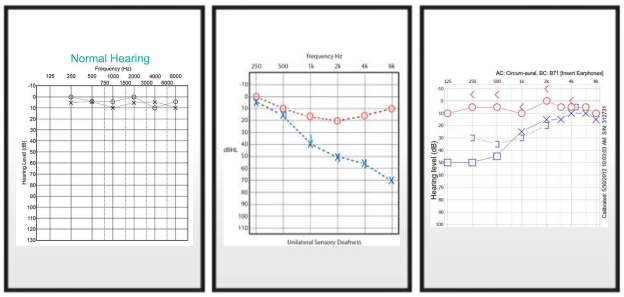
Hearing loss of at least 30 decibels occurring over three consecutive audiometric frequencies and lasting at least three days

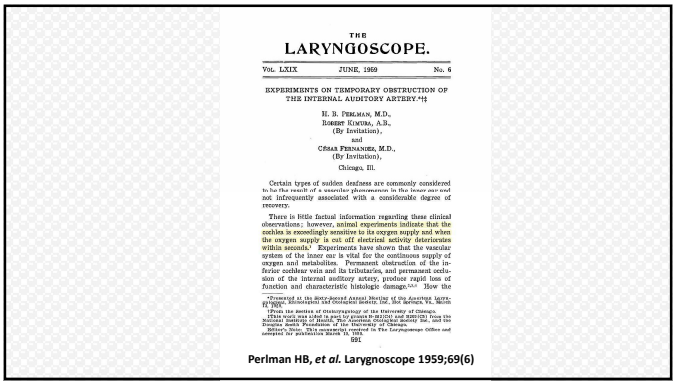
Majority are idiopathic ~10% have defined etiology

Postulated causes

- *Circulatory disturbances-vascular occlusions*
- *Acoustic trauma: firing weapons, nearby explosions & other sudden loud noises*
- *Viral infections*
- *Labyrinthine membrane leaks; cochlear membrane damage*
- *Neoplasms (sudden onset in rare cases); other abnormal tissue growth*
- *Ototoxicity; prescription & OTC*
- *Immune associated disease*







THE
LARYNGOSCOPE.

Vol. LXIX JUNE, 1959 No. 6

EXPERIMENTS ON TEMPORARY OBSTRUCTION OF THE INTERNAL AUDITORY ARTERY.*†‡

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(By Invitation),
and
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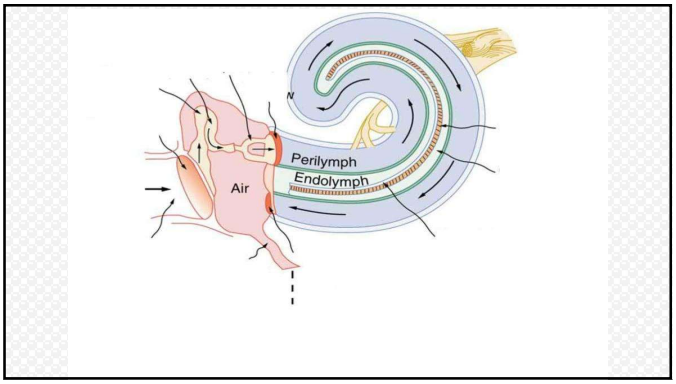
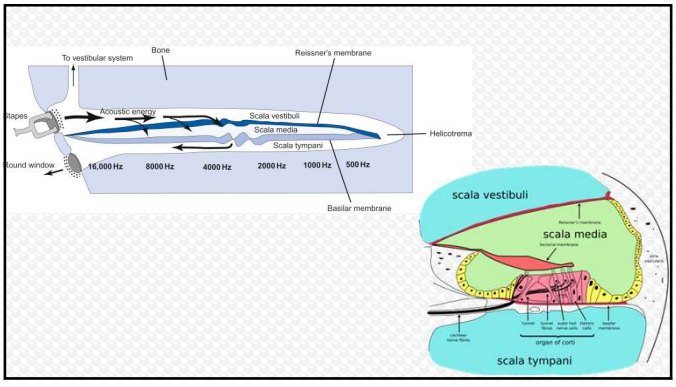
(By Invitation),
Chicago, Ill.

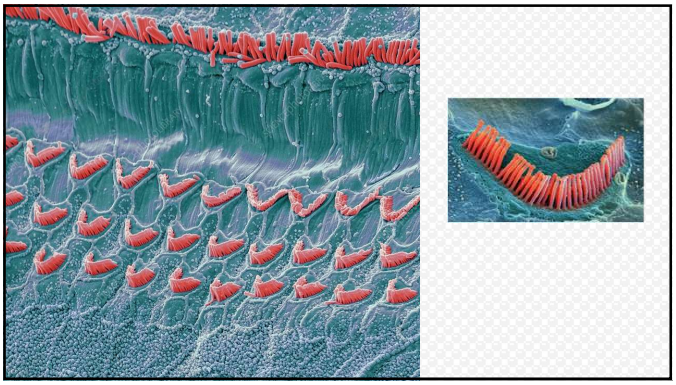
Certain types of sudden deafness are commonly considered to be the result of a vascular phenomenon in the inner ear and not infrequently associated with a considerable degree of recovery.

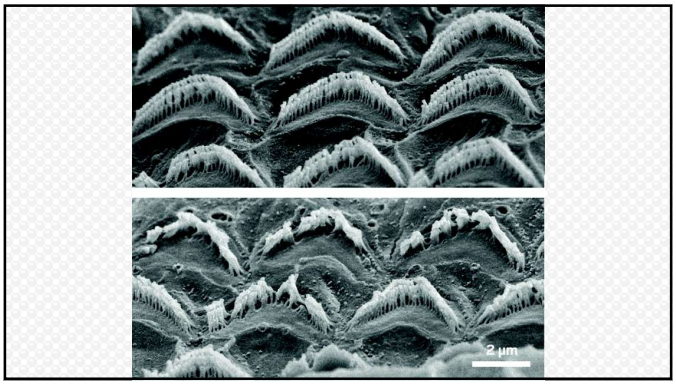
There is little factual information regarding these clinical observations; however, animal experiments indicate that the cochlea is exceedingly sensitive to its oxygen supply and when the oxygen supply is cut off electrical activity deteriorates within seconds.[1] Experiments have shown that the vascular system of the inner ear is vital for the continuous supply of oxygen and metabolites. Permanent obstruction of the inferior cochlear vein and its tributaries, and permanent occlusion of the internal auditory artery, produce rapid loss of function and characteristic histologic damage.[2,3,4] How the

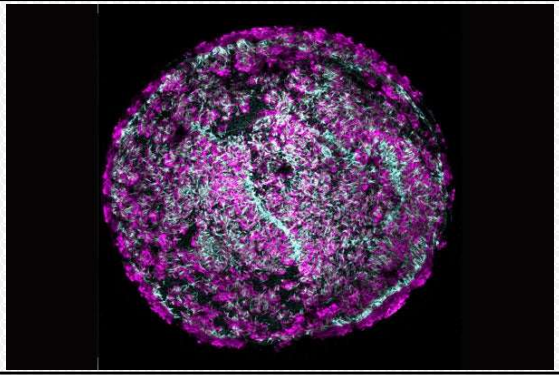
Perlman HB, *et al.* Laryngoscope 1959;69(6)











Identifying a hypoxia etiology

Depressed cochlear potentials failed to recover upon restoration of blood flow following brief transient anoxia

Kusakari J, *et al.* Auris Nasus Larynx 1981;8(2):55-64

In lowered oxygen states, cochlear evoked potentials < 20 mV lower than during normally oxygenated states

Offner FF, *et al.* Hear Research 1987;29(2-3):117-124

Acute sound shock wave induced decline of more than half (50-80%) of perilymph oxygen pressure

Lamm K, *et al.* HNO 1988;36(9):367-372

Oxygenation of cochlear perilymph decreased by 20% during high-intensity (125 dB) acoustic exposure

Scheibe F, *et.al.* Hear Research 1992;63(1-2):19-25

Early clinical studies of elevated oxygen as primary treatment

Idiopathic SSNHL. 3 groups randomized. HBO & stellate ganglion block = best outcomes

Goto F, *et al.* Acta Otolaryngol 1979;88:335-342

122 soldiers allocated to 4 groups. Combination HBO & vasodilators = best outcomes & reduced relapse

Pilgramm M, Schuman K.. Arch Otorhinolaryngol 1985;241

Compared carbogen breathing to other agents re: perilymph O_2 tension in 34 pts. yielded better results

Fisch U. Otolaryn Head Neck Surgery 1983;91(1):3-8

Studied 50 pts. randomized HBO or vasodilator. HBO significantly greater mean improvement p=0.005

Fattori B, *et al.* Ear Nose Throat J.. 2001;80(9):655-660

Hyperbaric oxygen as salvage therapy

50/155 pts failed primary therapy. Randomized HBO or ITS; only HBO groups improved all frequencies

Cvorovic L, *et al.* Otology Neurotology 2013;34:1021-1026

103 pts randomized: HBO (22), ITS (35), both (19) or control (27). Gains in both groups; combined *p=0.05*

Yang CH, *et al.* Otology Neurotology 2013;34:1411-1416

58/135 failed primary therapy; 44 offered 23 accepted HBO. Mean improvement 15.6dB vs 5.0 dB in 'controls'

Pezzoli M, *et al.* European Arch Otorhinolaryn 2015;272:

European Archives of Oto-Rhino-Laryngology (2019) 276:1835–1861
https://doi.org/10.1007/s00405-019-05462-7

556-119

REVIEW ARTICLE

The use of hyperbaric oxygen therapy in acute hearing loss: a narrative review

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Abstract

Background: Acute hearing loss can have a major impact on a patient's life. This holds true for both acute acoustic trauma (AAT) and idiopathic sudden sensorineural hearing loss (ISSHL), two demanding conditions for which no highly effective treatment options exist. This narrative review provides the rationale and evidence for HBOT in AAT and ISSHL.

Methods: Narrative review of all the literature available on HBOT in acute hearing loss; studies were retrieved from systematic searches on PubMed and by cross referencing.

Discussion: First, the etiological manifestations of acute hearing loss and the mechanism of action of HBOT were discussed. Furthermore, we have provided an overview of 48 studies that clinically investigated the effect of HBOT in the low cooperation setting of AAT and ISSHL. Finally, the evidence for HBOT in acute hearing loss was discussed in comparison with therapy, preferably within 48 h and in combination therapy consisting of HBOT and corticosteroids.

Implications for practice: HBOT has been used quite extensively for acute hearing loss in the last couple of decades. Based on the amount of studies showing a positive effect, HBOT should be discussed with patients (shared decision making) as optional therapy in case of AAT and ISSHL.

Keywords Acute hearing loss · Acute acoustic trauma · Idiopathic sudden sensorineural hearing loss · Hyperbaric oxygen therapy

Introduction

Acute hearing loss can have a major impact on a patient's life. This holds true for both acute acoustic trauma (AAT) and idiopathic sudden sensorineural hearing loss (ISSHL), two demanding conditions for which no highly effective treatment options exist. [1, 2].

In the US Army over a 5-year period, more than 592 hearing impairments were caused by AAT, and the Incidence of ISSHL in the USA, was estimated to be 27 per 100,000, which corresponds to more than 66,000 new cases per year [3–5].

The amount of hearing loss in AAT can vary between individuals and is based on the amount and duration of noise exposure [2]. For ISSHL, the amount of hearing loss can vary from 30 dB at three frequencies, to even losses > 90 dB [6]. Besides the amount of hearing loss, the (extent) recover sought for favorable due to the—albeit Eustachian—repair capacity of the ossicles; however, its preferred cases the chance of sustaining recovery is rather low. Furthermore, in case of AAT a temporary threshold shift can occur, which renders it difficult to (re)evaluate and ensure that there is no further damage of consequence for acquired hearing [7]. The definitive damage of sensorineural hearing recovery and other etiologies) were accessed unambiguously by (i.e., avoiding making comparison between studies or pooling of results difficult).

The auditory is an organ with an impressive activity, which is why it is extremely sensitive to ischemia and hypoxia in the blood [8]. However, because of the protected location of the cochlea in the temporal bone, blood supply is limited [9]. One of the mechanisms placing a possible role in both AAT and ISSHL is of vascular origin: lack of oxygen. For

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PubMed & cross-referencing > 68 clinical studies

Early treatment= *consistently better recovery*

within or after 48 hrs.
within or after 7 days
within or after 10 days
within or after 14 days

Higher losses appeared to benefit more when HBO used

Younger pts. (< 50 yrs.) appeared to benefit more

HBO as salvage therapy *"is not the most effective option"*

Other blood-flow promoting agents (vasodilators, diuretics, dextran, pentoxifylline) failed to show clinical effectiveness

"HBO time-consuming" 10 daily hospital visits

one study found no outcome difference if provided BID

"We recommend starting therapy as early as possible, preferably <48 hrs., using combination HBO and corticosteroids"

Bayoumy AB, de Ru JA. Euro Arch Oto-Rhino-Laryngol 2019:276

703-075

UNDERSEA & HYPERBARIC MEDICINE

International Multicenter Registry for Hyperbaric Oxygen Therapy: Results through June 2021

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ABSTRACT

Harlan NP, Pisk JA, Rees JR, et al. International Multicenter Registry for Hyperbaric Oxygen Therapy: Results through June 2021. Undersea Hyperb Med. 2022 First Quarter; 49(1): 275-287.

Introduction: The International Multicenter Registry for Hyperbaric Oxygen Therapy (International Report Registered Identifier (ISRR): 10.21961/IBRIS7) was established in 2011 to capture outcomes and complications data for both Undersea and Hyperbaric Medical Society (UHMS) approved and selected unapproved hyperbaric oxygen (HBO2) therapy indications.

Methods: A Research Electronic Data Capture (REDCap) template was designed and distributed to all participating centers for prospective data collection. Centers contributed de-identified demographic, treatment, complications, and outcome data. This report provides summary data on sites and enrollment, as well as pre- and post-treatment data on quality of life (EQ-5D-5L questionnaire), head and neck radiation outcomes, non-healing wounds (Wound Score), and idiopathic sudden sensorineural hearing loss. Data were analyzed mainly using the Wilcoxon signed-rank test.

Results: Twenty-five centers contributed data for 2,880 patients. The most common UHMS-approved indication was delayed radiation injury, followed by enhancement of wound healing, and carbon monoxide poisoning. Other indications were seen less frequently and are consistent with UHMS practice indications. Quality of life, head and neck radiation symptoms, Stroke wound scores, and hearing tests significantly improved after HBO2. Complications rates were low and comparable to previous reports. The registry also offered the ability to analyze factors that affect outcomes, such as smoking and severity of hearing loss.

Discussion: The registry accrues prospective data on defined outcomes from multiple centers and allows for analysis of factors affecting outcomes. This registry does not have a control group, which is a limitation. Nonetheless, the registry provides a unique, comprehensive dataset on HBO2 outcomes from multiple centers internationally. ♦

KEYWORDS: hyperbaric medicine; hyperbaric oxygen therapy; pulmonary function

INTRODUCTION

Currently hyperbaric oxygen (HBO2) therapy is approved by the Undersea and Hyperbaric Medical Society (UHMS) to treat 14 different conditions. Data supporting the use of HBO2 in these conditions can range from level A evidence, supported by multiple randomized controlled trials and meta-analysis data, to level C, supported by limited data or expert opinion. Use of HBO2 for carbon monoxide poisoning, enhancement of healing in problem

2011-2021: 2,880 pts. 30,577 treatments, 22 centers

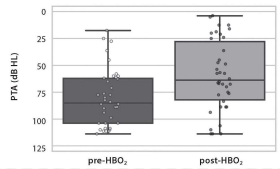
118 (4%) referred with ISSNHL

84 formally evaluated 83 HBO indicated

11 declined & 4 tx. elsewhere = 68 tx. "In Registry"

Harlan NP, *et al.* UHM 2022;49(1):275-287

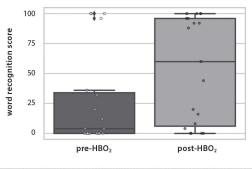
Figure 7. Pure-tone hearing averages



Mean improvement 20.8 dB. **N=38**

loss increased 16% decreased 76% p <0.001

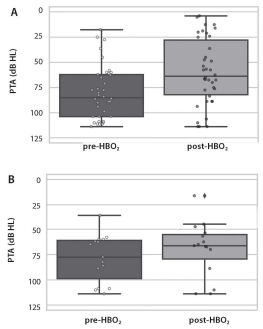
Figure 8. Word recognition scores



Mean improvement 26.9 dB. **N=19**

decreased 0% increased 53% p <0.005

Figure 9. Pure-tone average scores



Tx. Within 14 days of sx. onset N=38

87% PTA improvement p <0.001

81.2 dB loss > 52.8 dB loss

Tx. > 14 days of sx. onset N=15

27% PTA deterioration

60% PTA improvement p <0.019

556-129

medicina

MDPI

Article

Combination of Hyperbaric Oxygen Therapy and Oral Steroids for the Treatment of Sudden Sensorineural Hearing Loss: Early or Late?

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[4] Surgical Sciences Department, University of Turin, 10126 Turin, Italy
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Abstract: *Background and Objectives:* Several treatments are available for sudden sensorineural hearing loss (SSNHL), but no studies have compared the different treatments based on the delay from the onset of the disease. Our study aims to compare the effect of hyperbaric oxygen therapy (HBOT), oral steroids (OS), and combination of both therapies (HBOT + OS) for treating SSNHL. *Materials and Methods:* This randomized study analyzed 171 patients with SSNHL. Patients were evaluated by pure-tone audiometry test (PTA) at baseline (T0) and 28 days after treatment (T1). These groups were available (HBOT vs. OS vs. HBOT + OS). After baseline PTA, patients were randomly assigned to the HBOT group (*n* = 60), OS group (*n* = 55), and HBOT + OS group (*n* = 56). *Results:* Patients in the HBOT + OS and HBOT groups improved their auditory function (*p* < 0.05). HBOT was the best choice for treatment when started by 7 days from SSNHL onset, while HBOT + OS in case of late treatment. Performed SNHL recovered equally by HBOT and HBOT + OS (*p* > 0.05). Operating SNHL obtained better auditory results by HBOT compared to HBOT + OS (*p* < 0.05). Drawdrying SNHL had the worst auditory recovery, regardless of the therapy used (*p* < 0.05). *Conclusions:* Combination of HBOT and OS is a valid treatment for SNHL both in cases of early and late treatment. Combination of HBOT and OS was the choice with the best results in cases of treatment started <14 days from symptom onset.

Keywords: hyperbaric oxygen therapy; HBOT; sudden deafness; idiopathic sudden hearing loss; steroid therapy

1. Introduction

Sudden Sensorineural Hearing Loss (SSNHL) refers to the acute onset (less than 3 days) of perceptive hearing loss with a deficit over 30dB in three contiguous frequencies at least [1], because of its transitory and spontaneous resolution, the real prevalence SSNHL is unclear but estimated at 5 to 20 per 100,000 inhabitants. The symptom is commonly unilateral [2] and is usually associated with tinnitus [3], aural fullness [4], vertigo [5], nausea, vertigo, dizziness, and aural fullness) or peculiarly observed in population aged 45–52 (57 per 100,000) rather than in people < 34 years [1] per 100,000 [5–7]. The pathogenesis of SSNHL is still unknown [8], but several theories have been proposed [9]. The most likely SSNHL could arise from different diseases like viral infection, ischemic injuries, vascular disorders, drug toxicity, autoimmune inner ear disease [6] and psychiatric disorders. Authors have suggested that SSNHL may also be an early symptom of the onset of multiple sclerosis [7].

Randomized 171 pts between 2016-2019

Inclusion criteria

> 18 yrs.
onset within 30 days
unilateral and/or bilateral (1)
unknown cause
no fluctuations in hearing loss
normal Eustachian tube function
all underwent MRI to r/o retro-cochlear pathology

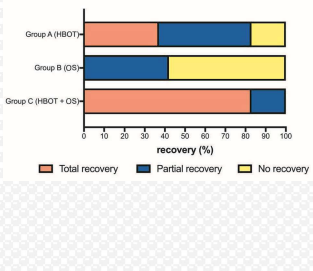
Block Randomization

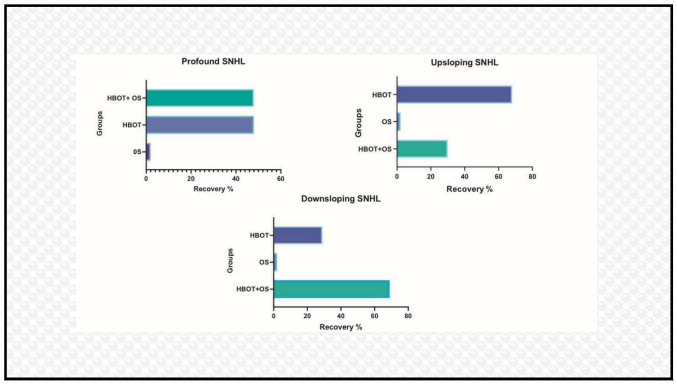
Group A: *HBO therapy exclusively 2.5 ATA x 90 min.* 60

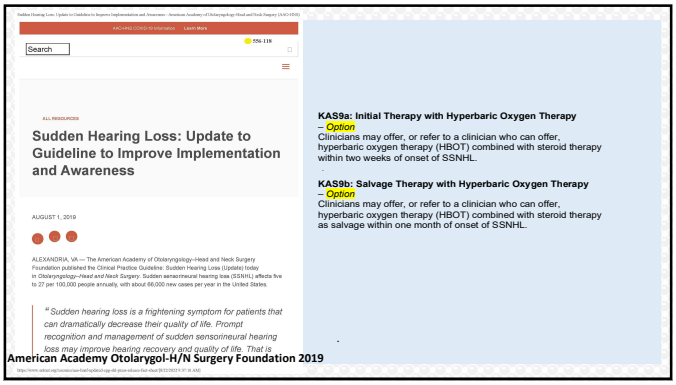
Group B: *Oral steroids exclusively; prednisone* 55

Group C: *Combination HBO & steroids* 56

Cavaliere M, *et al.* Medicina 2022;58:1421







American Academy Otolaryngol-H/N Surgery Foundation 2019

Flowchart for Treatment of Sudden Sensorineural Hearing Loss *

Classic Presentation of Symptoms in SSNHL Patients

Abrupt onset, usually upon wakening, at least 30 dB within 3 days over at least 3 contiguous frequencies, +/- tinnitus, aural fullness, dizziness, vertigo

Self-Referred Patient
Complete physical exam
Discuss diff. diagnosis
Probable SSNHL- refer to ENT

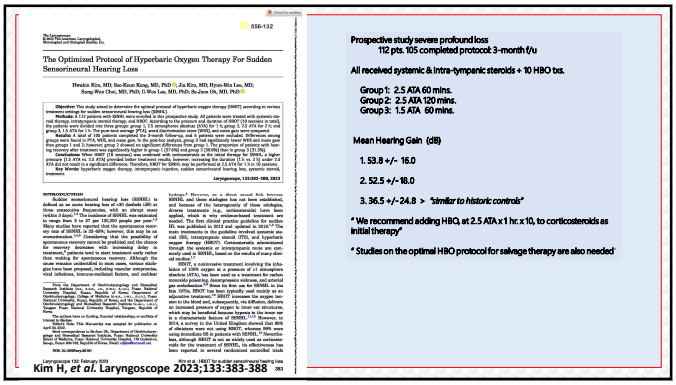
Patient Presents to ENT
Complete ENT exam; perform audiogram
Order MRI: eval. for retro-cochlear pathology
May perform additional testing

Hyperbaric Medicine Consultation

- Evaluate for SSNHL Selection Criteria: a) Confirmed dx SSNHL; b) The SSNHL is moderate to profound (**>40 dB**) and c) The patient presents < 14 days from onset * *
- Complete Exam & History: Evaluate for any contraindications to HBO therapy
- Call ENT: Discuss dosing of oral prednisone (1 mg/kg/day) with slow taper over 2-3 weeks; consider IT steroids; schedule repeat audiogram post-HBO therapy
- Begin HBO Therapy: 100% O_2 at 2.0-2.5 ATA for 90 minutes daily for 10-20 sessions
- When HBO Therapy is completed: Refer patient back to ENT; timely follow-up with both

** American Academy Otolaryngologists-Head Neck Surgery Foundation recommends HBO for up to 3 months from symptom onset

* UHMS Practice Guideline 2019



Kim H, *et al.* Laryngoscope 2023;133:383-388

Prospective study severe profound loss
112 pts. 105 completed protocol: 3-month f/u

All received systemic & intra-tympanic steroids + 10 HBO txs.

Group 1: 2.5 ATA 60 mins.
Group 2: 2.5 ATA 120 mins.
Group 3: 1.5 ATA 60 mins.

Mean Hearing Gain (dB)

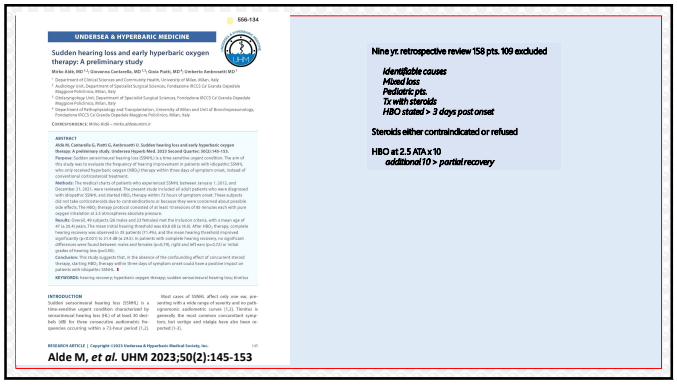
1. 53.8 +/- 16.0

2. 52.5 +/- 18.0

3. 36.5 +/- 24.8 > **similar to historic controls**

*** We recommend adding HBO, at 2.5 ATA x 1 hr. x 10, to corticosteroids as initial therapy***

*** Studies on the optimal HBO protocol for salvage therapy are also needed**



Alde M, *et al.* UHM 2023;50(2):145-153

Nine yr. retrospective review 158 pts. 109 excluded

Identifiable causes
Mixed loss
Pediatric pts.
Tx with steroids
HBO stated > 3 days post onset

Steroids either contraindicated or refused

HBO at 2.5 ATA x 10
additional 10 > partial recovery

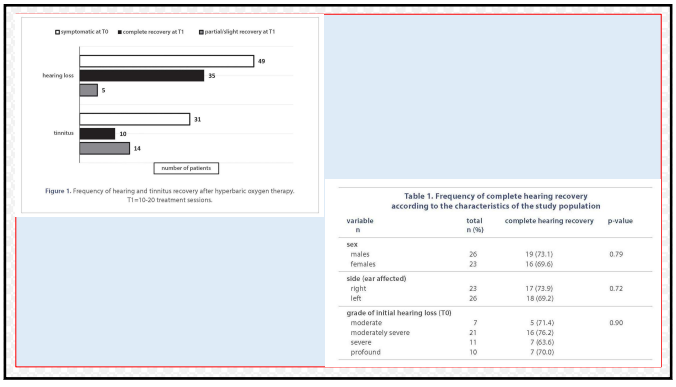


Figure 1. Frequency of hearing and tinnitus recovery after hyperbaric oxygen therapy. T1=10-20 treatment sessions.

Table 1. Frequency of complete hearing recovery according to the characteristics of the study population

variable n	total n (%)	complete hearing recovery	p-value
sex			
males	26	19 (73.1)	0.79
females	23	16 (69.6)	
side (ear affected)			
right	23	17 (73.9)	0.72
left	26	18 (69.2)	
grade of initial hearing loss (T0)			
moderate	7	5 (71.4)	0.90
moderately severe	21	16 (76.2)	
severe	11	7 (63.6)	
profound	10	7 (70.0)	

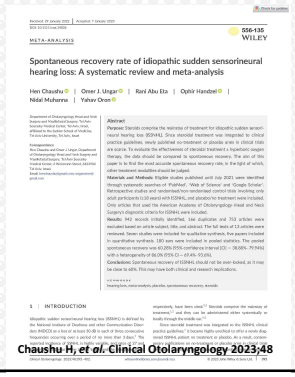
Hearing loss associated with diving/other hyperbaric exposures

Differential diagnosis

"Sensorineural" secondary to inner ear decompression sickness (IEDCS)

"Conductive" secondary to inner ear barotrauma (IEB)

	IEDCS	IEB
Symptom onset	Upon surfacing	Common upon compression; ascent; upon surfacing
Ear equal. difficulty	Not anticipated	Yes, commonly during compression +/- ascent
Otoscopic exam	Unremarkable	Associated with Teed Scale TM changes
Associated symptoms	Other DCS	Isolated to inner ear
Dive profile	Risk for DCS	No/low DCS risk; rapid compression
Hearing loss type	Sensorineural	Conductive



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556–135 WILEY

META-ANALYSIS

Spontaneous recovery rate of idiopathic sudden sensorineural hearing loss: A systematic review and meta-analysis

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Abstract

Purpose: Steroids comprise the mainstay of treatment for idiopathic sudden sensorineural hearing loss (ISSNHL). Since steroidal treatment was integrated to clinical practice guidelines, newly published no-treatment or placebo arms in clinical trials are scarce. To evaluate the effectiveness of steroidal treatment a hyperbaric oxygen therapy, the data should be compared to spontaneous recovery. The aim of this paper is to find the most accurate spontaneous recovery rate, in the light of which, other treatment modalities should be judged.

Materials and Methods: Eligible studies published until July 2021 were identified through systematic searches of 'PubMed', 'Web of Science' and 'Google Scholar'. Retrospective studies and randomised/non-randomised control trials involving only adult participants (≥18 years) with ISSNHL, and placebo/no treatment were included. Only articles that used the American Academy of Otolaryngology–Head and Neck Surgery's diagnostic criteria for ISSNHL were included.

Results: 942 records initially identified, 166 duplicates and 753 articles were excluded based on article subject, title, and abstract. The full texts of 13 articles were reviewed. Seven studies were included for qualitative synthesis, five papers included in quantitative synthesis. 180 ears were included in pooled statistics. The pooled spontaneous recovery was 40.20% (95% confidence interval [CI] = 26.68%–79.74%) with a heterogeneity of 86.0% (95% CI = 69.4%–93.6%).

Conclusions: Spontaneous recovery of ISSNHL should not be over-looked, as it may be close to 40%. This may have both clinical and research ramifications.

hearing loss, meta-analysis, placebo, spontaneous recovery, steroids

1 | INTRODUCTION

Idiopathic sudden sensorineural hearing loss (ISSNHL) is defined by the National Institutes of Deafness and other Communication Disorders (NIDCD) as a loss of at least 30 dB in each of three consecutive frequencies occurring over a period of no more than 3 days.[1] The

respectively, have been cited.[2,3] Steroids comprise the mainstay of treatment,[4–7] and they can be administered either systemically or locally through the middle ear.[8]

Since steroidal treatment was integrated to the ISSNHL clinical practice guidelines,[1] it became highly unethical to offer a newly diagnosed ISSNHL patient no treatment or placebo. As a result, contem-

60% spontaneous resolution

Of 766 articles retrieved 753 excluded
613 of which no spontaneous recovery reported

Of 13 remaining 6 had unusual protocol
so, 7 reviewed involving 780 ears

Spontaneous recovery didn't mean "recovered"
ranged from 33-54% per NIDCD definition up to 80% using alternative definitions

Chaushu H, *et al.* Clinical Otolaryngology 2023;48

AETNA

Clinical Policy Bulletin # 0172 Hyperbaric Oxygen Therapy: Last revision 4/8/2022

Idiopathic sudden sensorineural hearing loss (SSHL) > **30 dB** affecting greater than 3 consecutive frequencies of pure-tone thresholds when member has failed oral and intra-tympanic steroids & **HBOT is initiated within 3 months after onset** (up to 20 sessions).

CIGNA

Medical Coverage Policy Hyperbaric Oxygen Therapy #0057: Effective Date: 5/15/2022

Idiopathic sudden sensorineural hearing loss (ISSHL) **within four weeks of symptom onset**.

HUMANA

Medical Coverage Policy HUM-0450-026: Review date 4/28/2022

Idiopathic sudden sensorineural hearing loss as an adjunctive treatment to systemic or intratympanic steroid therapy with documentation of diagnosis from a specialist (e.g., otolaryngologist) when the following criteria are met:

1. At least three consecutive frequencies are affected with no identifiable cause, **AND**
2. Decrease in hearing of **greater than or equal to 30 decibels (dB)**