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ABSTRACT

Objective: The aim of this study was to evaluate recovery in hearing acuity of idiopathic sudden sensorineural hearing loss (ISSNHL) based on timing of onset to determine how late is too late to medically intervene.

Study Design: A retrospective chart review was conducted in patients previously treated for primary complaint of sudden hearing loss (HL). Participants meeting inclusion criteria were analyzed based on timing of onset to service date, age, gender, associated ear, associated symptoms as well as recovery in pure tone average (PTA) and recovery in word recognition scores (WRS).

Setting: All patients seeking treatment for SSNHL were seen in a hospital/medical setting by otolaryngologists/otologists.

Methods: Utilizing the hospital's medical record system, an initial sample of 696 participants treated for ISSNHL from 2016-2019 was collected. Of the 696 participants, 161 met the inclusion criteria and were analyzed.

Results: Timing of symptoms onset to treatment initiation as well as recovery detail were statistically significant in recovery anticipation.

Conclusion: Pure tone average (PTA) and word recognition score (WRS) recovery two variables analyzed as part of hearing recovery based on symptom onset to treatment initiation. Of the recovered participants, 14.9% and 42.2% experienced with BothRecovery or EitherReocvery respectively. Recovery detail, especially WRS recovery, is a key variable which should be analyzed when anticipating recovery of symptoms. WRS recovery was also identified in participants who sought treatment after 42 days of onset, suggesting recovery is possible beyond clinical guidelines set by the American Academy of Otolaryngology-Head and Neck Surgery (AAO).

INTRODUCTION

Sudden SNHL (SSNHL) impacts 5-27 out of 100,000 Americans every year.[2] This symptom is defined as a HL that is greater than 30 dB in 3 consecutive frequencies within 3 days of onset. For a physician to diagnose a true SSNHL, the distinction in nature of HL is imperative. This distinction is determined through a comprehensive audiometric evaluation. The American Academy of Otolaryngology (AAO)-Head and Neck Surgery's most updated guidelines affirm treatment for ISSNHL be immediate whether the appropriate treatment plan involves oral steroids or a steroid injection[2]. According to AAO, studies suggest oral steroids can be effective in the treatment of ISSNHL up to six weeks[2]. However, prognosis beyond six weeks is very poor and further treatment or initiating treatment beyond is not recommended.

Literature has repeatedly analyzed audiogram configurations and pure tone average (PTA) improvements with full, partial or no recovery status.[4,9, 10] However, it has yet to dedicate focus to the impact ISSNHL also has on speech clarity and word understanding[13]. This study seeks to show clinical significance of considering changes in word understanding as part of hearing recovery expectations based on timing of onset to treatment initiation by answering the following research questions: What clinical insights does monitoring word recognition impairment in addition to pure tone average/audiometric configuration offer as it relates to anticipated hearing recovery in patients diagnosed with idiopathic sudden sensorineural hearing loss? How late is too late to medically intervene and anticipate recovery in hearing related symptoms in those diagnosed with idiopathic sudden sensorineural hearing loss?

The aim of this study is to highlight the importance of word recognition impairment as well as determine how late is too late to medically intervene and anticipate recovery in hearing in this population.

KEY DEFINITIONS

PTA_Recovery is defined as (PTA_Pre - PTA_Post) >= 25

WRS_Recovery is defined as (WRS_Post >= 50) & (WRS_Post - WRS_Pre) >= 12) (*a minimum post treatment WRS of >50% and >12 point improvement)*

BothRecovery indicates a patient is **both** PTA_recovered **and** WRS_recovered (i.e., satisfies both criteria)

EitherRecovery indicates a patient is **either** PTA_recovered **or** WRS_recovered (i.e., satisfies either-or-both criteria).

	DAYS FROM ONSET
GROUP 1	0-14
GROUP 2	15-28
GROUP 3	29-42
GROUP 4	>42

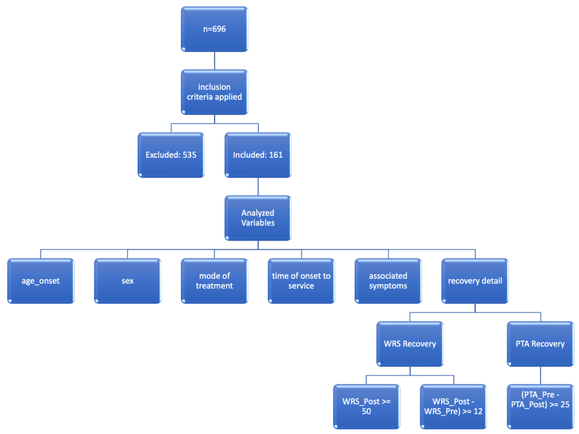
METHODS

Participants from this study sought treatment for SSNHL with the Jefferson Balance and Hearing Center and its corresponding five satellite offices. Medical records were extracted for analysis and review from the hospital's medical record system during the years 2016-2019 with primary and secondary diagnosis codes of H90.5, H90.3, H91.21, and H91.22. A total of 696 initial records were extracted for review focusing on primary complaint of sudden HL during November 26, 2016-December 31, 2019. Of the 696 participants, 594 did not meet the inclusion criteria, leaving a sample size of 161 participants. The inclusion and exclusion criteria were indicated as follows:

INCLUSION CRITERIA	EXCLUSION CRITERIA
• 18 years of age or older • ICD-10 code: H90.5, H90.3 (diagnosed asymmetric or symmetric sensorineural hearing loss) • ICD-10 code: H91. 2xx (H91.21, H91.22: Confirmed sudden hearing loss) • Classifying criteria: hearing loss >30 dB HL at three consecutive frequencies within three days of onset of symptoms • Years: 2016-2019 • Diagnosed with ISSHL. Idiopathic means there is no identifiable medical cause for hearing loss. • No prior treatment for sudden hearing loss at alternate medical practice.	• Hearing loss dxs: conductive, mixed • Patients seen for second opinion within Jefferson enterprise for sudden hearing loss. • Hx of sudden hearing loss in same affected ear • Cerumen Impaction • Known hx of tinnitus, otologic symptoms • Confirmed diagnosis of Meniere's Disease • Confirmed diagnosis of Labyrinthitis • Confirmed diagnosis of COVID-19 • Confirmed diagnosis of Perilymph Fistula (PLF) • Audiologic evaluation conducted externally • Confirmed cancer diagnosis with intended or previous treatment of chemotherapeutic agents with or without radiation • Confirmed diagnosis of transverse and longitudinal temporal bone fracture • Confirmed diagnosis of retrocochlear pathology through imaging (MRI) • Confirmed diagnosis of autoimmune and vascular pathologies. • Acoustic trauma, i.e., cochlear damage, tympanic membrane perforation, ossicular chain disarticulation

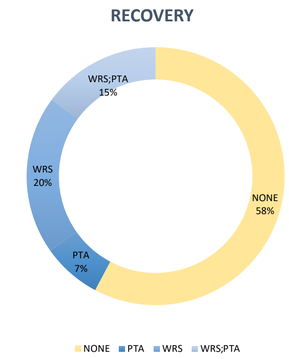
Gender, age at time of onset, affected ear, timing of onset to date of service, associated symptoms, mode of treatment and recovery detail were documented. PTA was calculated by averaging 500 Hz, 1 kHz, and 2 kHz unless otherwise indicated to employ Fletcher's average. Fletcher's average takes the average of two consecutive frequencies when inter-octaves exceed 15 dB rom 500-2kHz. When implementing Fletcher's average on an initial audiometric result, the same methodology on the final evaluation for cohesion was followed.

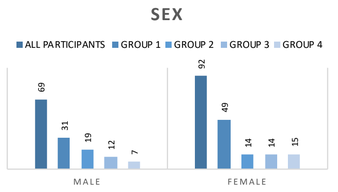
As part of the statistical data analysis, Welch 2-sample t for proportions, Fisher's exact, and Pearson's x^2 were applied. The relationship between PTA_Recovery and sex, age_service, cSympOnset2Tx_v3, AsscSymp_Full, AsscSymp_Tinn, AsscSymp_VD and TxMode was analyzed based on 161 participants by fitting a multivariable logistic model using R with four separately definded endpoints: WRS_Recovery, PTA_Recovery, BothRecovery, and EitherRecovery. Backward stepwise variable selection for the multivariable model by Akaike information criterion (AIC) is performed using R package MASS.



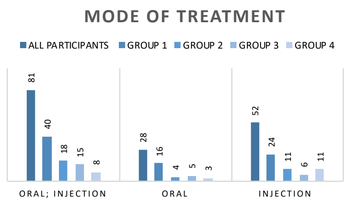
RESULTS

The average age of the included sample size at the time of service was 59.0±15.7. Of the 161 participants, 93 (57.8%) did not achieve EitherRecovery or BothRecovery. However, 68 of the 161 participants (42.2%) did experience EitherRecovery or BothRecovery of hearing impairment.

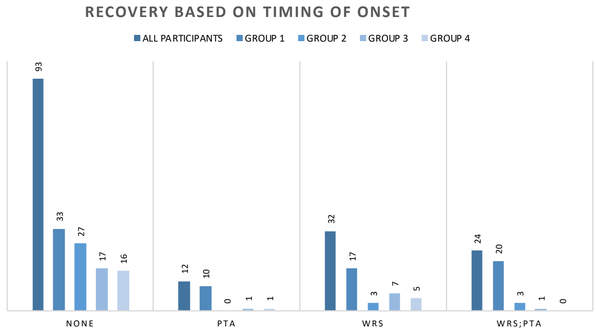




Of 161 included participants, 57.1% (92) were females compared to male suggesting idiopathic sudden sensorineural hearing affects women more often than men. However, this observation does not influence anticipation of recovery.



The collective sample was comprised of 161 included participants. While mode of treatment held no statistical significance on anticipated recovery, a combination of oral steroid and injection was prescribed by the treating physician: this is true for the overall sample size but across each group as well.



Recovery detail focuses on improvement in word recognition score (WRS), pure tone average (PTA) or both (WRS; PTA) based on defined parameters. WRS recovery based on timing of onset was determined to be statistically significant. As seen above, WRS improvement was noted in group 4 which is comprised of participants seeking treatment after more than 42 days of onset of symptoms.

SIGNIFICANT FINDINGS

Group 4 (both PTA and WRS recovery) shows that while recovery may yield a poor prognosis, WRS recovery occurred in those treated after 42 days of onset, a **significant** finding.

Among all groups it is seen that the distribution of sex among the sample size was not significant as it related to anticipation of recovery. Additionally, a common treatment regimen of combination of oral steroids and injection was more commonly utilized by physicians as more time passed from symptom onset. While this emerging pattern is an interesting finding, the mode of treatment was not statistically significant: a detail which agrees with existing literature. Results indicate the recovery detail is statistically significant ($p<0.05$) when compared to cSympOnset2Tx. Further, WRS recovery is statistically significant in the anticipation of recovery. WRS recovery occurred most throughout the groups either in isolation or combined with PTA recovery.

The significance of WRS recovery was further shown and supported by implementing a multivariable logistic model to assess the relationship between cSympOnset2Tx and several defined endpoints: WRS_Recovery and Sex, Age_Service, cSympOnset2Tx_v3, AsscSymp_Full, AsscSymp_Tinn, AsscSymp_VD and TxMode. With WRS_Recovery defined as the end point, the odds ratio proved clinically significant when analyzing WRS to timing of onset and age_service. With $p<0.05$, multivariable logistic model showed that the odds of WRS_Recovery decreases in group 2 compared to group 1 and group 4 compared to group 1 with an odds ratio of 0.212 (95% CI, 0.076-0.592) and 0.396 (95% CI, 0.178-0.884) respectively. WRS_Recovery is more likely to occur when treatment is sought within two weeks of onset (Group 1).2,10 While the odds of recovery show to decrease the further out from onset, the multivariable logistic model reveals the older in age_service, the higher the odds are of anticipated WRS_Recovery with an odds ratio of 1.036 (95% CI, 1.012~1.061).

WRS_Recovery: 161 PARTICIPANTS	Odds Ratio (95% CI)	Signif.
cSympOnset2Tx_v3 $^{r}14<O2S\leq28$ vs $O2S\leq14_{,}$	0.212 (0.076-0.592)↓	*.003
cSympOnset2Tx_v3 $^{r}O2S>28$ vs $O2S\leq14_{,}$	0.396 (0.178-0.884)↓	*.024
cSympOnset2Tx_v3 $^{r}O2S>28$ vs $14<O2S\leq28_{,}$	1.868 (0.612-5.702)↑	.273
Age_Service	1.036 (1.012-1.061)↑	*.003

WRS recovery is seen regardless of how much time has passed from onset in some variation, more than PTA which was seldom noted in isolation. Monitoring WRS throughout treatment for ISSNHL is significant and critical for post-treatment expectations.

CONCLUSION

Individuals seeking medical care for ISSNHL beyond 42 days of symptom onset should be considered for treatment despite current clinical practice guidelines implications of poor prognosis. While recovery in PTA is unlikely, as shown by existing literature and within this study, WRS recovery *does* occur and plays a critical role in guiding appropriate rehabilitation options once discharged from treatment. Monitoring WRS recovery as part of a treatment care plan is critical for overall anticipated recovery.

LIMITATIONS

While modes of treatment were analyzed within the data sample, documentation of specific steroid used was not tracked, nor do the results reflect the number of times treatment was repeated to seek overall recovery in hearing.

Another limitation to note within this study is the lack of available research for definitive classification of WRS improvement to guide recovery parameters. As such, 12% improvement and less was not included, potentially missing a sizable amount of the included participants; WRS recovery was documented as >12% WRS from onset to final audiometric evaluation at treatment discharge. Further study into this area is essential to help serve as reliable guidelines for defined WRS recovery in cases of SSNHL.

Finally, within the data collection sample and variables assessed, severity of loss itself was not further broken down for analysis. Report of hearing loss as a whole was included once exclusion criteria were applied.

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