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  - Click dropdown menu on the right “preview”
  - Click layout
- Choose # of pages per sheet from dropdown menu
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GSI AMTAS: Implementation and Interpretation Case Studies

gsi
Grason-Stadler

GSI Audiology Team

- Application Support
- Training
- R&D testing

Tony Lombardo

Laura Prigge

Karen Morris

Learning Outcomes

1) After this course, the participant will be able to use the quality indicators to interpret the quality of the automated audiogram.

2) After this course, the participant will be able to use the speech results to interpret the quality of the automated speech testing.

3) After this course, the participant will be able to determine most appropriate next steps for patients based on the results of the automated audiometry.

Are you “on the fence” when it comes to Automated Audiometry?

Brief History of Automated Audiometry

- Bekesy Audiometry
  - Considered Special Test
  - Not used routinely
- Military Annual Screening
- Hearing Conservation Programs
- Research Programs

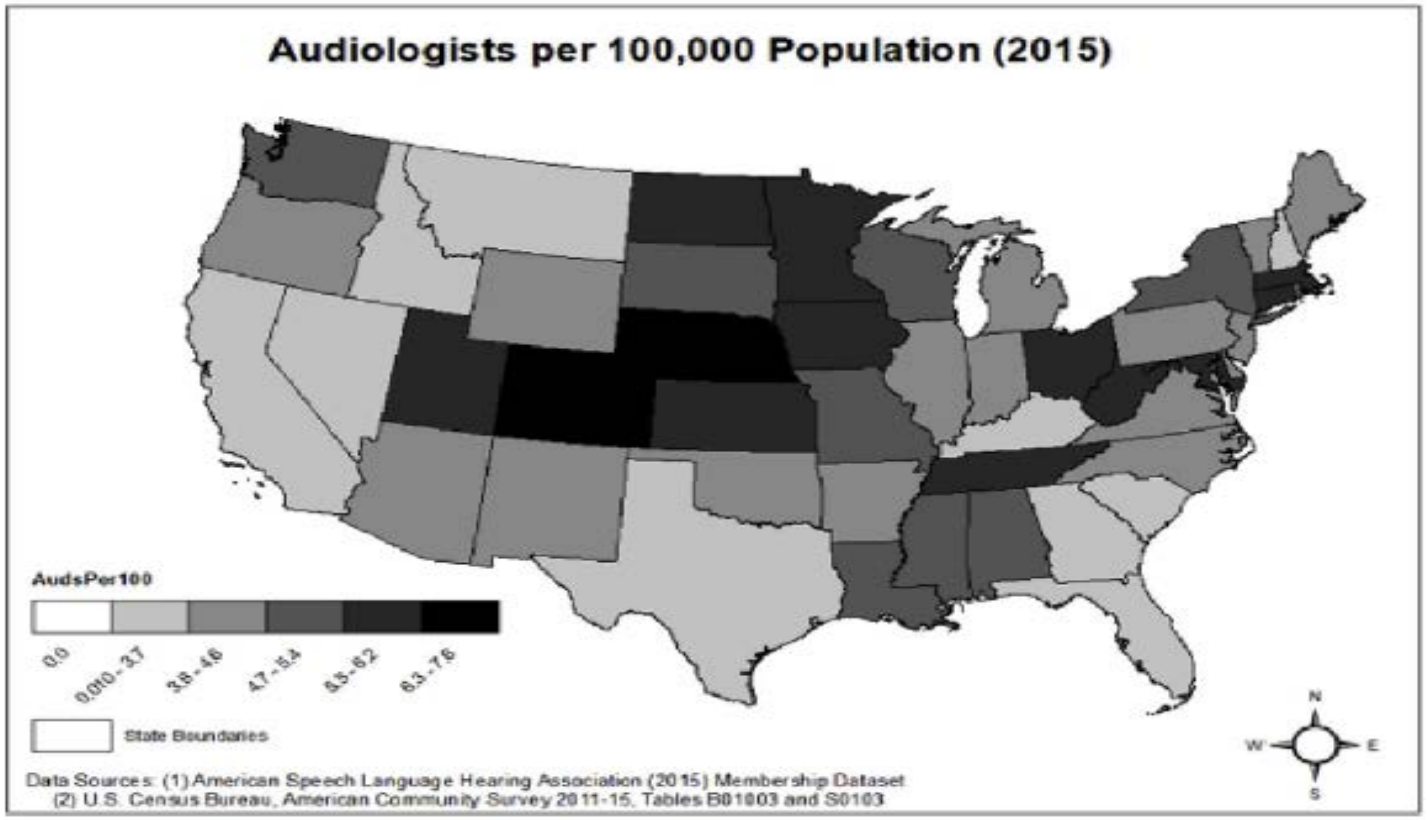
Historically Screening: Confirm normal or refer for more testing. Air conduction only. Little diagnostic relevance.

Current Status of Automation

- Technology advancements in medical professions
  - Blood pressure
  - Vision testing
  - Pure tone audiometry
- Provides continuous measurements
- Analyze and quantify behavioral responses
- Correlate responses for test accuracy

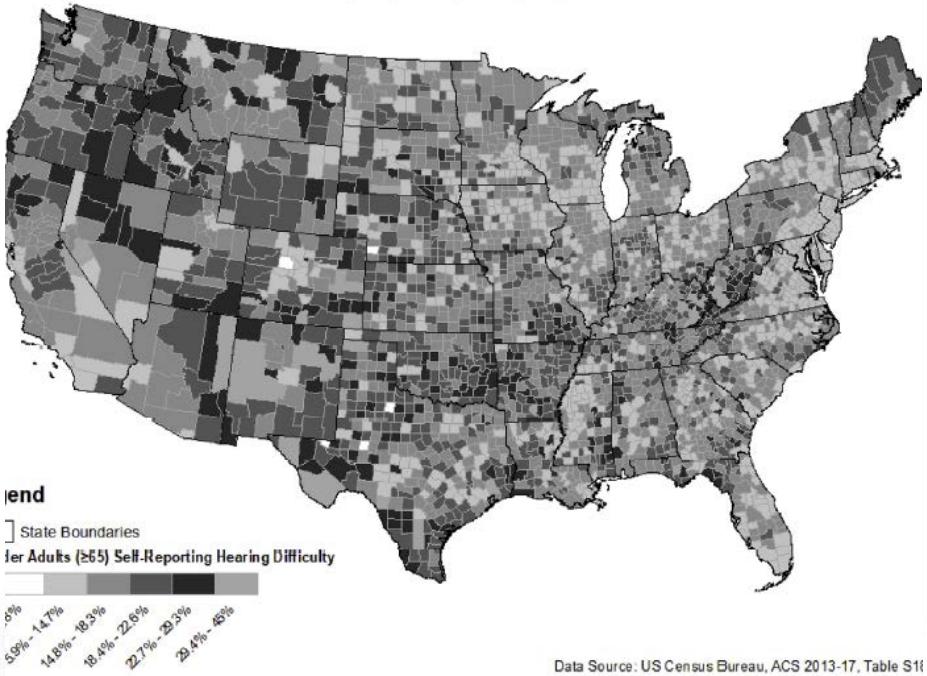
The Access Factor

Landscape of Audiology in the US



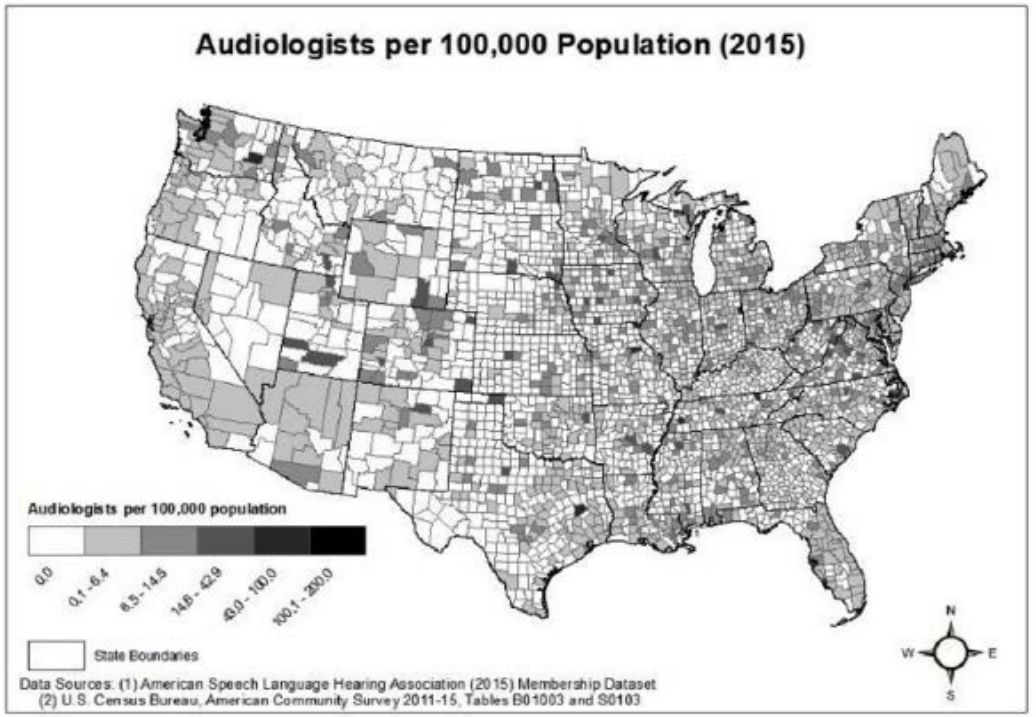
Planey AM. (2019) Audiologist availability and supply in the United States: A multi-scale spatial and political economic analysis. *Social Science And Medicine 222,* 216-224.

In the 2013-17 period, the proportion of older adults (≥65) self-reporting difficulty hearing ranged from 3.2% to 44.4%.



Data Source: US Census Bureau, ACS 2013-17, Table S1

timated percentage of county population aged ≥65 reporting hearing difficulty (data source: U.S. Census Bureau, American community sur Table S1810).



Increasing need for hearing tests in the US

- Population 2020-2060
  - 333 Million → 417 Million
- Prevalence of hearing impairment
  - 17% →18%
  - 56 Million → 75 Million
- Number of hearing tests per patient per year
  - Assuming bi-annual evaluation
  - Minus 25% total tests for normal hearing
- Total Number of hearing tests needed per year
- 35 Million →47 Million

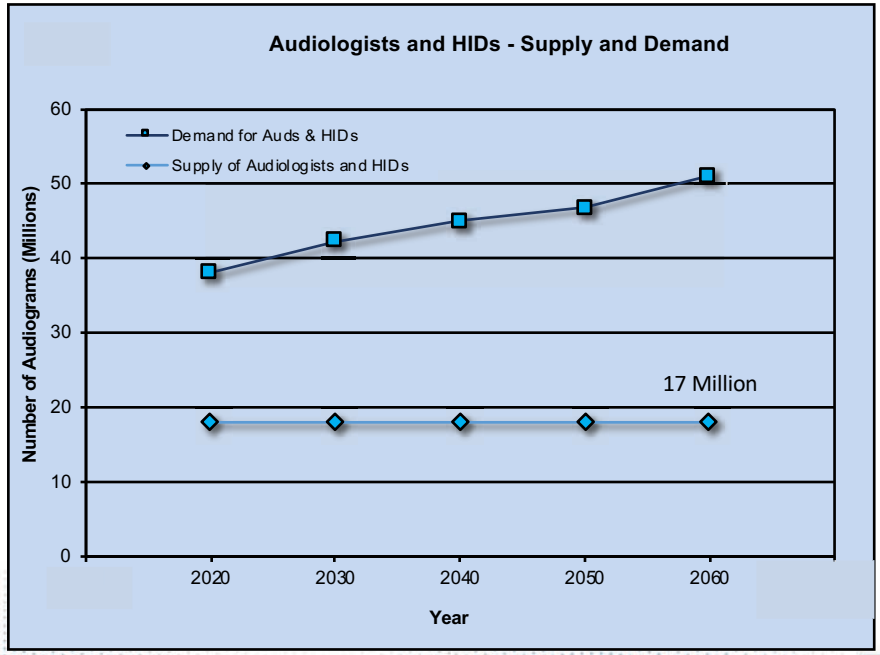
Margolis, Robert, PhD., presented at Coalition of Global Hearing Health, 2019

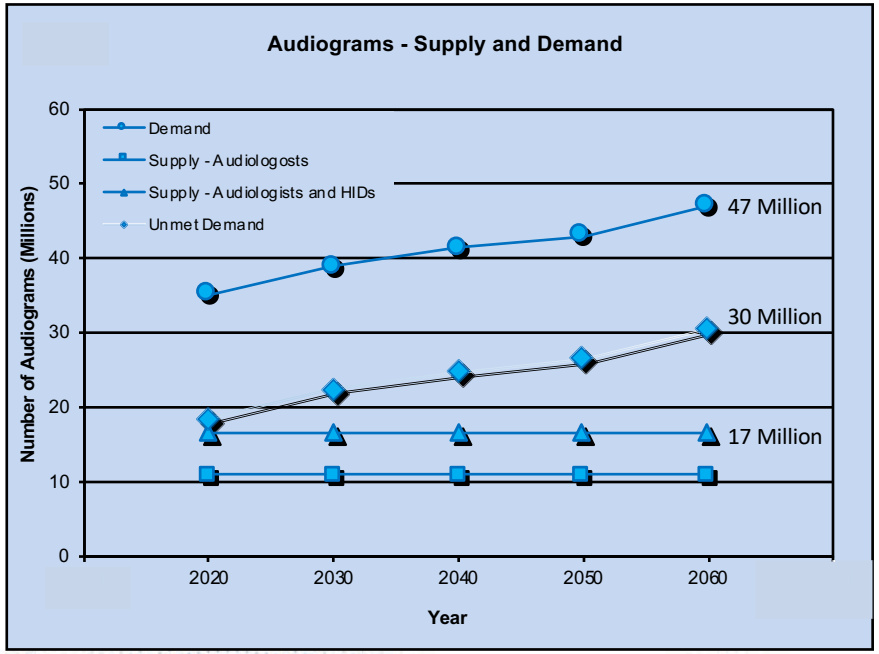
What does this mean?

- Number of FT Audiologists
  - 12, 019 → 12, 019
- Number of FT HAD/HIS
  - 6,000 → 6,000
- Number of Hearing Tests Per Year Per Tester
  - 3 per workday
  - 920 per year
  - 17 Million →17 Million

Margolis, Robert, PhD., presented at Coalition of Global Hearing Health, 2019

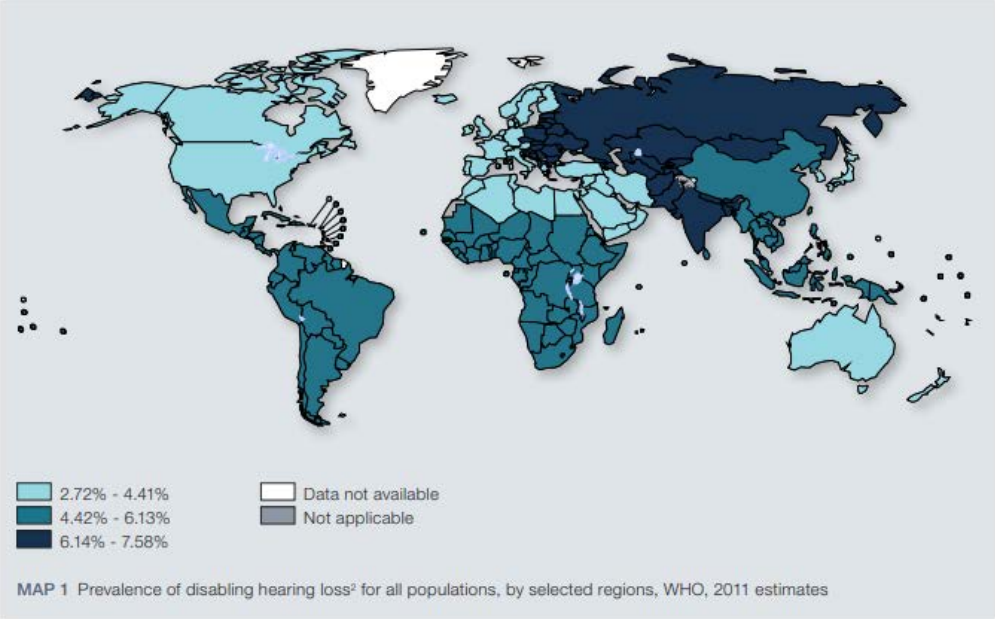
Unable to meet demand.





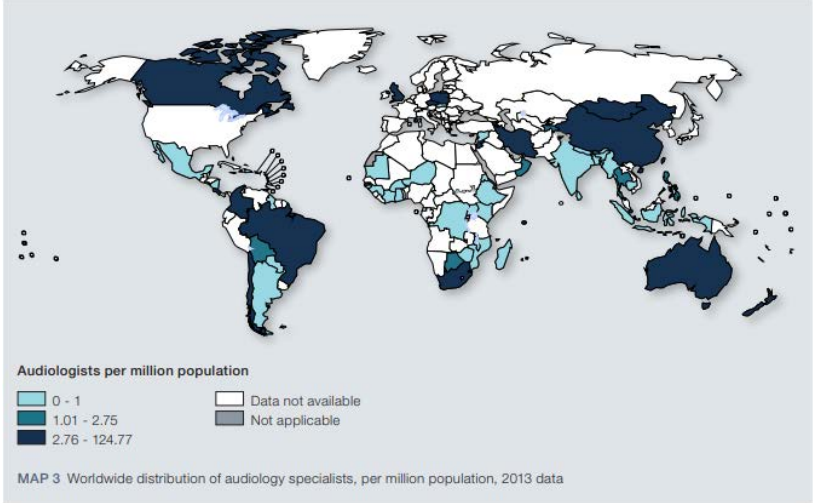
Margolis, Robert, PhD., presented at Coalition of Global Hearing Health, 2019

- Disabling Hearing Loss



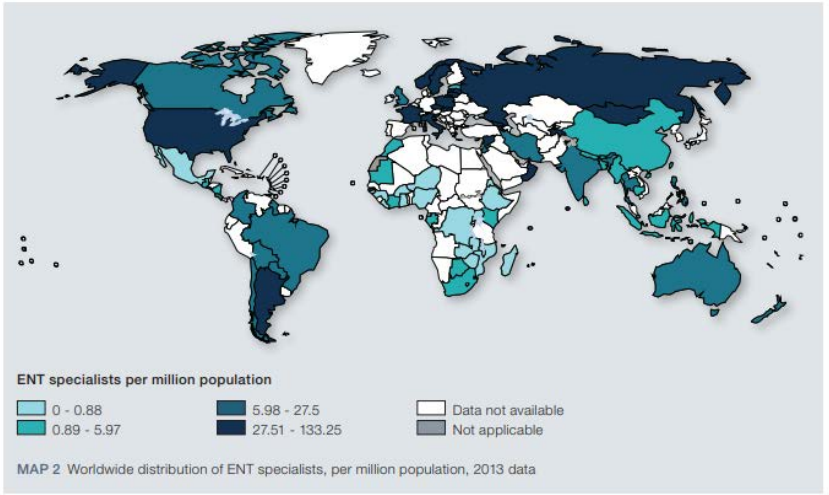
MAP 1 Prevalence of disabling hearing loss[2] for all populations, by selected regions, WHO, 2011 estimates

- Audiologists per million



MAP 3 Worldwide distribution of audiology specialists, per million population, 2013 data

ENT per million



MAP 2 Worldwide distribution of ENT specialists, per million population, 2013 data

World Health Organization. **Multi-country assessment of national capacity to provide hearing care.** ISBN 978 92 4 150657 1 (NLM classification: WV 270) © World Health Organization 2013

How do we address this increasing need?

- Increase the workforce
- TeleMedicine/TeleAudiology
- More efficient use of the workforce
  - Use of technicians
  - Audiology Assistants

How do we address this increasing need?

- Automation
  - Pure tone air/bone
  - Speech
  - Basic Diagnostic tests

Brief History of Pure Tone Audiometry

- 1924: First pure tone methods published in the *Laryngoscope*
- 1944: Original Hughson-Westlake Method article published
- 1959: Carhart and Jerger method published
- 1970: Adaptive psychophysical procedures (used in research)
- 2004: ANSI Standards guidance on pure tone audiometry

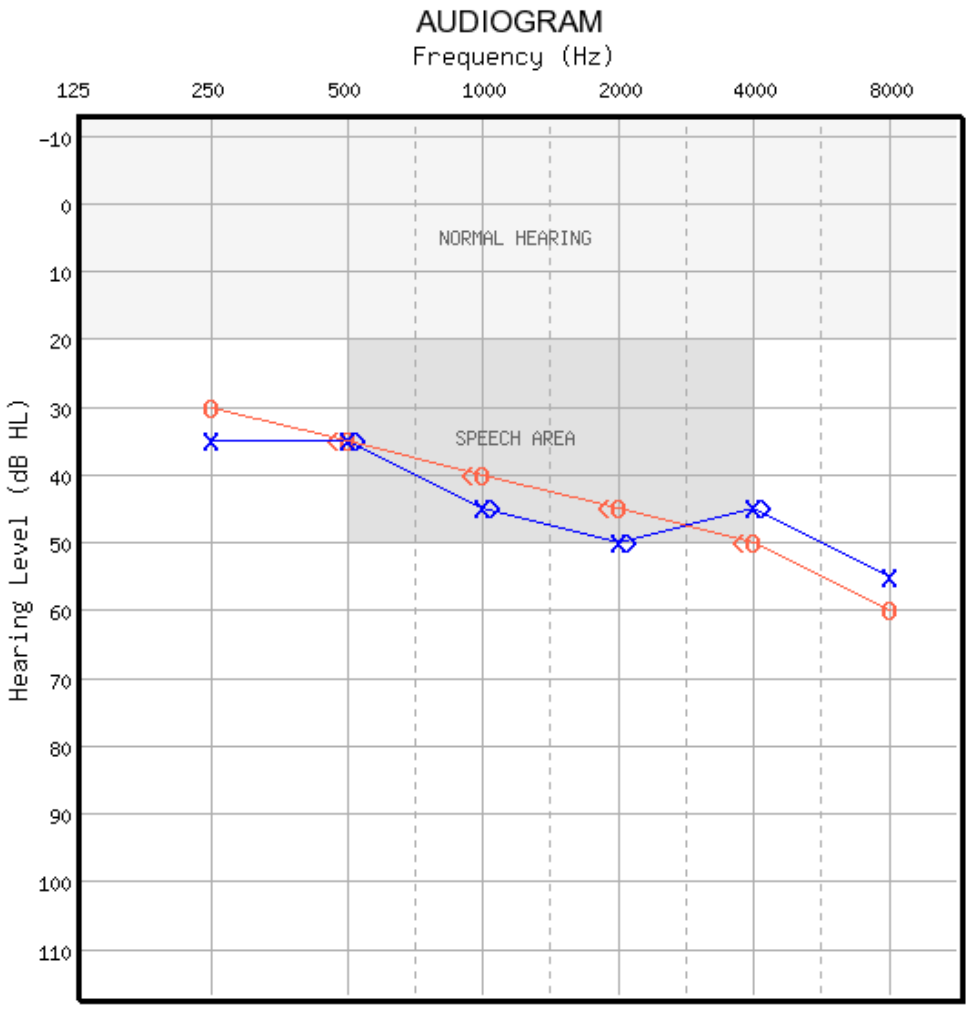
leaves many procedural variables to the discretion of the tester

Manual audiometry has persisted without much change for 90 years

How consistent are pure tone tests from clinician to clinician?

How much variability is there in pure tone testing?

What if a patient brings in a recent audiogram from another clinic?


AUDIOGRAM
Frequency (Hz)
125
250
500
1000
2000
4000
8000
-10
0
10
20
30
40
50
60
70
80
90
100
110
Hearing Level (dB HL)
NORMAL HEARING
SPEECH AREA

It is very common for the audio to be repeated because of lack of confidence in the original results.

The Human Factor – Tester Bias

- Experienced audiologists learn certain tricks that ensure accuracy.
- The varying skill levels of testers and their testing methods result in widely varying accuracy.
- Testers are sensitive to different cues that suggest that the patient may not be responding consistently and accurately.
- Experienced audiologists can basically predict the audio based on the first few responses and patient history.
- Experienced audiologists have the confidence to cut corners without affecting the integrity of the results.

Is there a standardized method for pure tone audiometry?

not as consistent as we thought

The Missing Link: Standardization

- The basic diagnostic eval does not require skillset of an expert audiologist
- “tell the story” of patient behavior during evaluation
- AMTAS provides patented Quality indicators to assist in interpretation
- Patented and validated

Standardized Automated Audiometry

Qualind™: A Method for Assessing the Accuracy of Automated Tests. Margolis, et al,2007, JAAA, 18: 78-89.

- Patented method for determining the accuracy of a test results
- Data was collected at three sites from a wide range of settings, patient demographics, and hearing loss characteristics.
- Large subject sample (n = 120), a strong relationship was found between predicted and measured accuracy.
- Method may be useful for automated test procedures when skilled professionals are not available to provide quality assurance.

9 Quality Indicators (Qualind)

	QUALITY ASSESSMENT (Air & Bone)		
1	**Predicted Accuracy**	GOOD	
	Quality Indicators	Value	%ile
2	Predicted Avg. Abs. Diff. (dB)	5.287	0
3	Masker Alert (%)	0.000	0
4	Time per Trial (s)	2.688	0
5	False Alarm (%)	3.846	35
6	Avg. Test Retest Diff. (dB)	5.000	46
7	QC Fail (%)	0.000	0
8	ABG > 35	0.000	0
9	ABG < -10	0.000	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌐	⌐

- **Predicted Accuracy** (Overall Quality -Good, Fair, Poor)
- **Predicted Average Absolute Difference** –Difference between automated and manual thresholds
- **Masker Alerts**-thresholds where masking may have been too high or low
- **Time per Trial** - average time from stimulus to patient response
- **False Alarm Rate** – number of times patient responded with no stimulus presented divided by number of trials when no stim present
- **Average Test-Retest Difference** – average difference between 1 KHz test and retest in right and left hear
- **Quality Check Fail Rate** – number of times patient did not respond to stimulus above threshold divided by the number of measured thresholds
- **Number of Air / Bone Gap > 35 dB** – number of air bone gaps that exceed 35 dB
- **Number of Air / Bone Gap < -10 dB** – number of air bone gaps that are less than 10db

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LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

- **Predicted Accuracy** (Overall Quality - Good, Fair, Poor)
  - "reliability" judgment found on audiogram forms assumes that a skilled audiologist can observe certain patient behaviors and characteristics that predict accuracy.

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LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

- **Predicted Average Absolute Difference** –Difference between automated and manual thresholds
- Derived from study 2 data
- Helps establish confidence in the patient responses and accuracy of thresholds.

Study 1: Inter-tester Differences for Manual Audiometry

- 3 sites; 6 patients (included normal and sensorineural hearing loss) tested by 2 audiologists (with at least 10 years of experience)
  - Air-conduction thresholds absolute differences ranged from 2.4 to 6.3 dB. The overall mean absolute difference for all frequencies was 4.1 dB, with a 95% confidence interval of 2.3 to 6.0 dB.
  - For bone-conduction thresholds, mean absolute difference for frequencies tested, excluding 250 Hz, was 5.4 dB, with a 95% confidence interval of 2.9 to 7.9 dB.

Study 2: AMTAS Manual Threshold Comparison

- 30 subjects (5 normal hearing, 25 hearing impaired) were tested with AMTAS and manual audiometry
- Air-conduction absolute differences (AMTAS-Manual), ranged from 3.0 to 4.5 dB with mean absolute difference 3.6 dB.
- Bone-conduction thresholds (AMTAS-Manual), ranged from 7.4 to 8.1 dB with mean absolute difference of 7.7 dB. (Differences attributed to forehead vs mastoid placement and calibration)

9 Quality Indicators (Qualind)

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LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

- **Masker Alert**–thresholds where masking may have been too high or low
- Masking presented on every presentation
- Indicates over masking or under masking

9 Quality Indicators (Qualind)

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LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

- **Time Per Trial**–average time from stimulus to patient response

9 Quality Indicators (Qualind)

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LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

- False Alarm Rate
  - Catch trials are presented randomly throughout the test to allow a quantitative measurement of false-alarm rate.
  - Patients can get into a “rhythm”
  - Software delivers a message designed to keep them on task

9 Quality Indicators (Qualind)

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LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌐	⌐

- **Avg Test-Retest Difference**–average difference between 1 KHz test and retest in right and left hear.

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LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

- **Quality Control Fail Rate**
  - Number of times patient did not respond to stimulus above threshold divided by the number of measured thresholds
  - QC check is performed after each threshold determination by presenting a stimulus with a higher intensity than the threshold level.
  - A “No” response to that stimulus is a “Quality Check Fail.”

9 Quality Indicators (Qualind)

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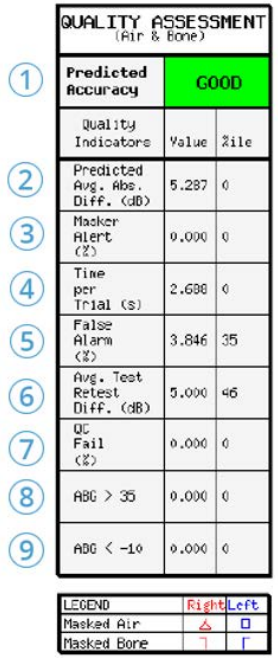
8	ABG > 35	0.000	0
9	ABG < -10	0.000	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

- Air Bone Gaps–
- Number of Air / Bone Gap > 35 dB – number of air bone gaps that exceed 35 dB
- Number of Air / Bone Gap < -10 dB – number of air bone gaps that are less than 10db

9 Quality Indicators (Qualind)



QUALITY ASSESSMENT
(Air & Bone)

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LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

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Audiogram Classification (AMCLASS)

- Audiogram is given three descriptive categories based on
  - Configuration: Normal, Flat, Sloping Hearing Loss, Rising, Trough, Peaked, and other
  - Severity: Normal, Mild, Moderate, Severe, Profound
  - Site of Lesion: Conductive, Sensory, Mixed
- Audiogram is analyzed for interaural asymmetry.

How does AMTAS automate speech testing?

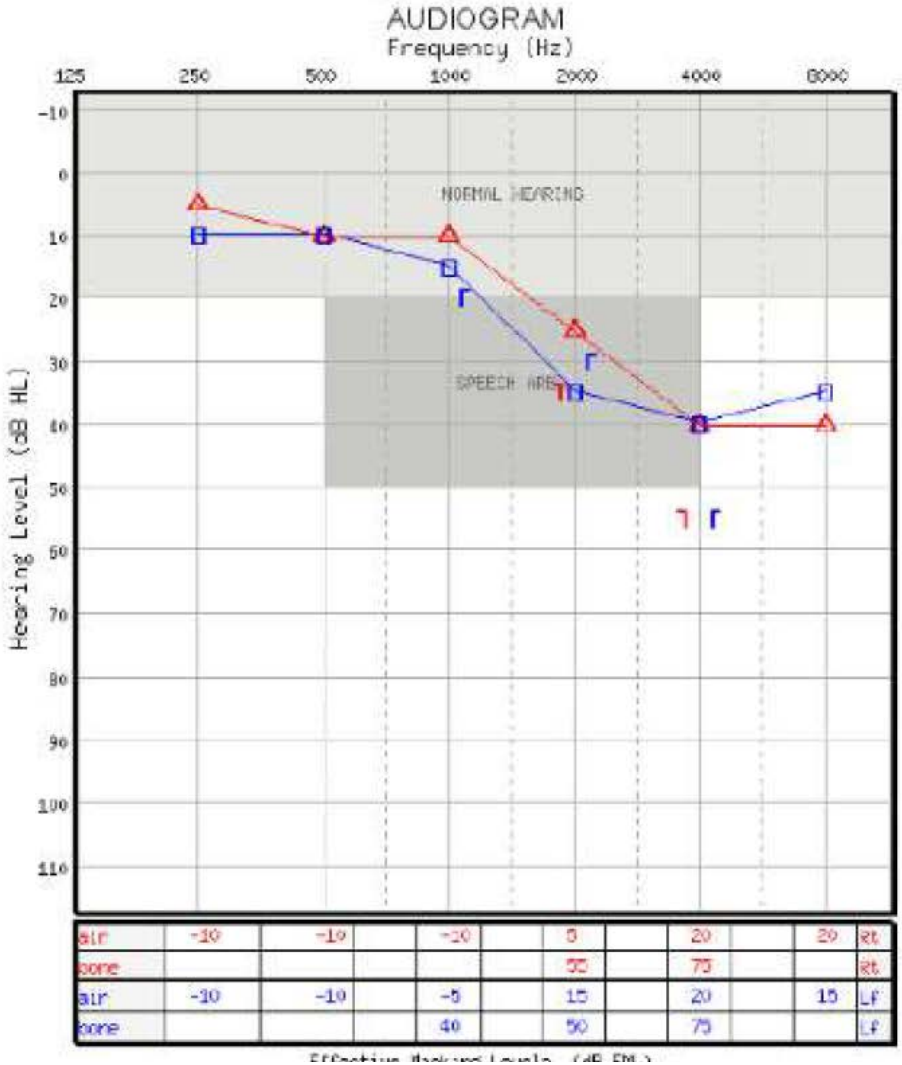
- Forced Choice
- SRT
- WRS
- Task becomes TOO easy

Margolis, et.al., Automated Forced-Choice Word-Recognition Tests, Poster, AAS, 2016

Case Studies

- All submitted from actual audiologists using AMTAS
- Variety of settings
  - Large medical practice
  - ENT practice
  - Private practice with medical referrals

GSI AMTAS™ Hearing Report



air	-10		-10		-10		5	20	20	Rt
bone							55	70		Rt
air	-10		-10		-5		15	20	15	Lf
bone					40		50	75		Lf

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	10
Masker Alert	0 %	0
Trial Time	3.0 s	60
False Alarm	3 %	25
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 30	0	0
ABG < -10	0	0

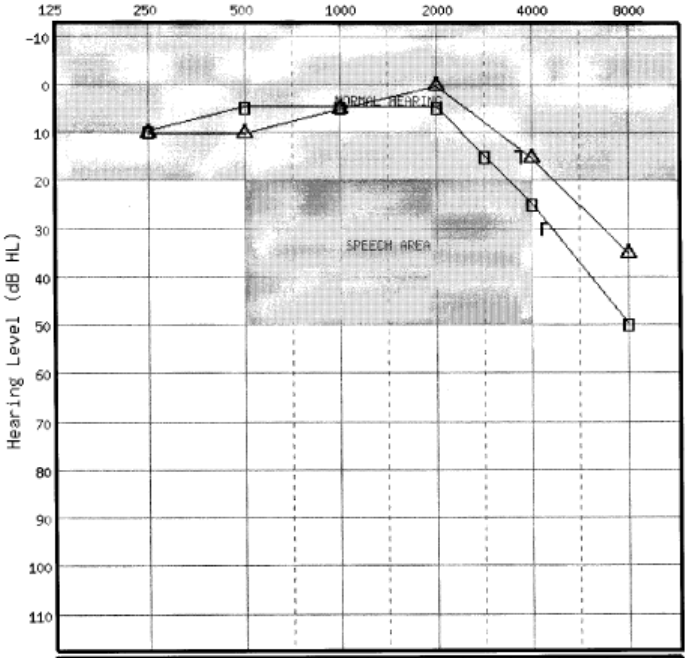
LEGEND	Right	Left
Masked Air	△	□
Masked Bone	[	[

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	10
Masker Alert	0 %	0
Trial Time	3.0 s	60
False Alarm	3 %	25
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 30	0	0
ABG < -10	0	0

GSI AMTAS™ Hearing Report

AUDIOGRAM

Frequency (Hz)



QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	5
Masker Alert	0 %	0
Trial Time	3.9 s	65
False Alarm	0 %	0
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌉	⌈

air	-10	-10		-10		-10		-5	15	Rt
bone								60		Rt
air	-10	-10		-10		-10	-5	5	30	Lf
bone								50		Lf

Effective Masking Levels (dB EML)

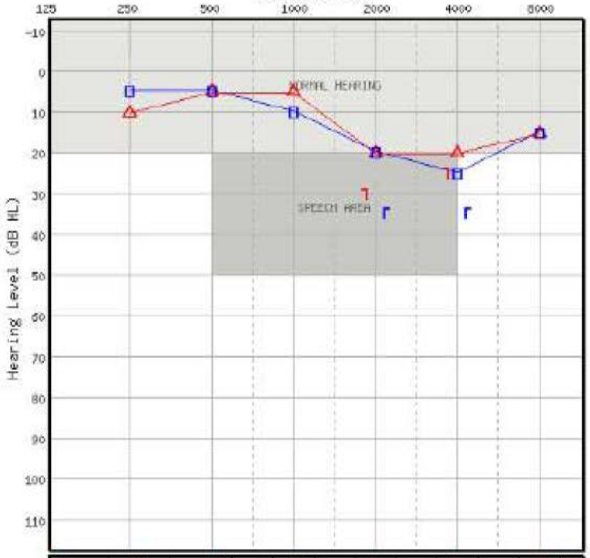
AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	MILD	Flat Hearing Loss	SENSORINEURAL	Symmetric
Left	NORMAL-MILD	Sloping Hearing Loss	SENSORINEURAL	

Speech Recognition Report						
Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	5	-5	88	27	7	NU6-4
Left	5	-5	88	27	7	NU6-2

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	5
Masker Alert	0 %	0
Trial Time	3.9 s	65
False Alarm	0 %	0
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

GSI AMTAS™ Hearing Report

AUDIOGRAM
Frequency (Hz)



QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	10
Masker Alert	0 %	0
Trial Time	3.1 s	10
False Alarm	5 %	40
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	1	50

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌐	⌐

air	-10	-10		-10		0		-5	RL
bone					50	60			RL
air	-10	-10		-10		0		-5	LF
bone					55	55			LF

Effective Masking Levels (dB EML)

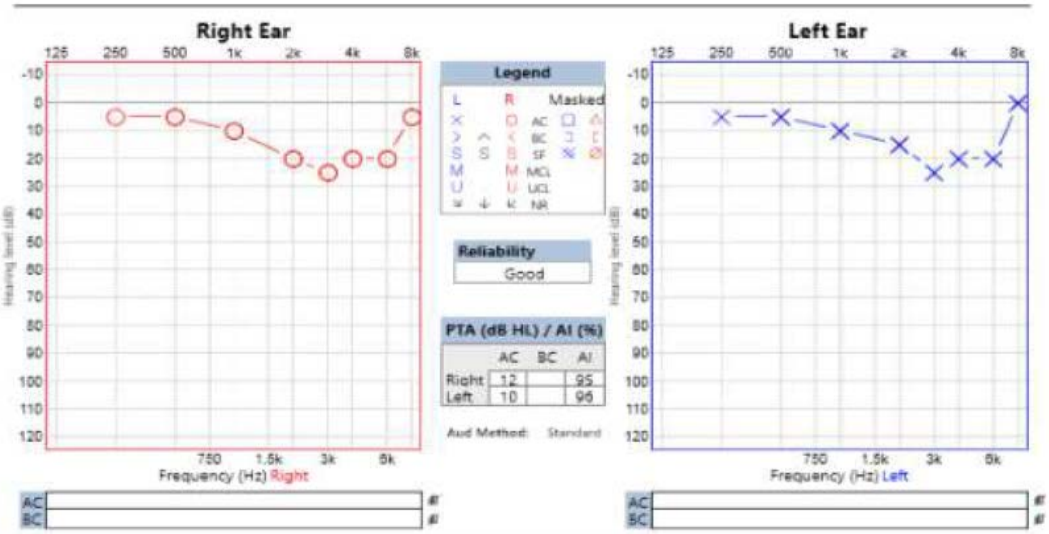
AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symetry
Right	NORMAL		Cannot Determine	Symmetric
Left	NORMAL		Cannot Determine	

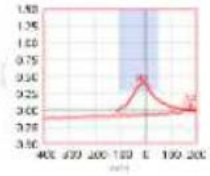
Speech Recognition Report

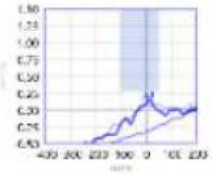
Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	10	5	100	65	45	NU6-2
Left	12	5	84	65	45	NU6-1

Correction added to bone threshold at 4000 Hz.: 15 dB.

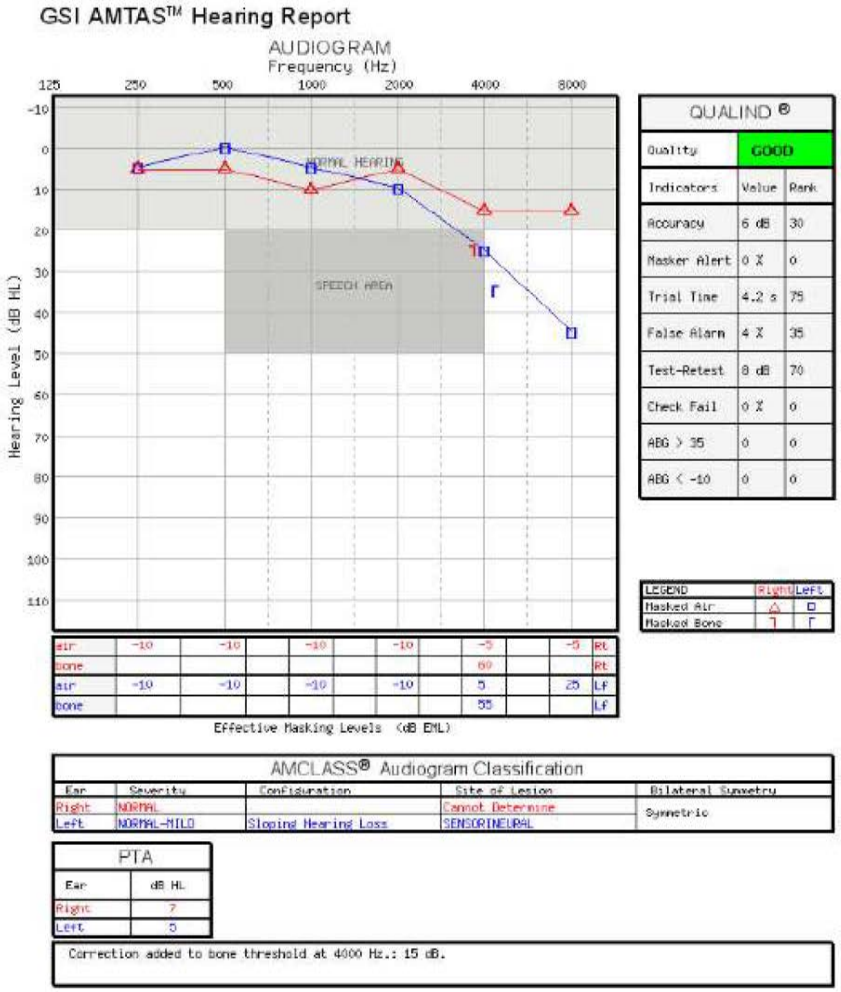


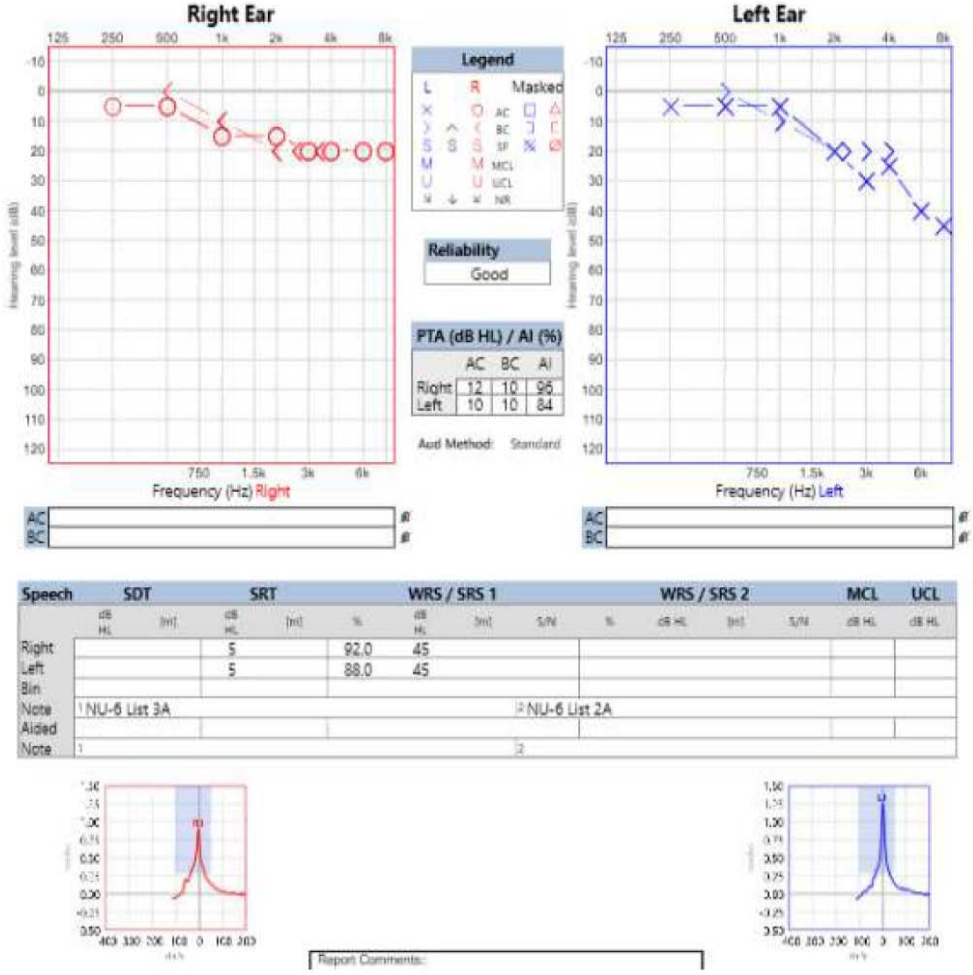
Speech	SDT		SRT			WRS / SRS 1				WRS / SRS 2				MCL	UCL
	dB HL	(m)	dB HL	(m)	%	dB HL	(m)	S/N	%	dB HL	(m)	S/N	%	dB HL	dB HL
Right			5		100.0	45									
Left			5		100.0	45									
Bin															
Note	1 NU-6 List 3A					2 NU-6 List 2A									
Aided															
Note	1					2									



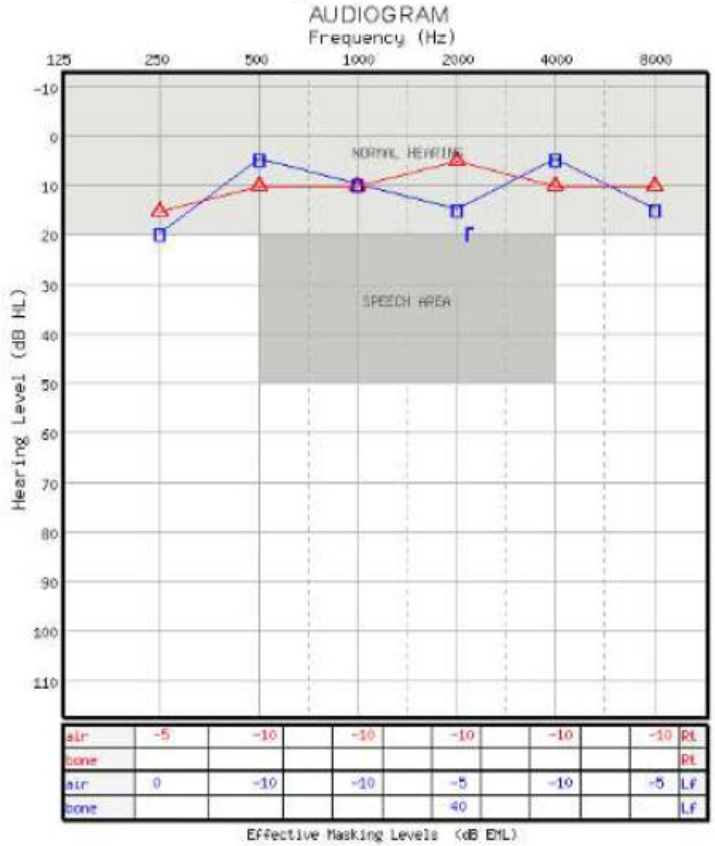


Report Comments:


GSI AMTAS™ Hearing Report
AUDIOGRAM
Frequency (Hz)
125 250 500 1000 2000 4000 8000
Hearing Level (dB HL)
NORMAL HEARING
SPEECH AREA
QUALIND ®
Quality GOOD
Indicators Value Rank
Accuracy 6 dB 30
Masker Alert 0 % 0
Trial Time 4.2 s 75
False Alarm 4 % 35
Test-Retest 8 dB 70
Check Fail 0 % 0
ABG > 35 0 0
ABG < -10 0 0
LEGEND Right Left
Masked Air
Masked Bone
air -10 -10 -10 -10 -5 -5 Rt
bone 60 Rt
air -10 -10 -10 -10 5 25 Lf
bone 55 Lf
Effective Masking Levels (dB EML)
AMCLASS® Audiogram Classification
Ear Severity Configuration Site of Lesion Bilateral Symmetry
Right NORMAL Cannot Determine
Left NORMAL-MILD Sloping Hearing Loss SENSORINEURAL
Symmetric
PTA
Ear dB HL
Right 7
Left 5
Correction added to bone threshold at 4000 Hz.: 15 dB.


Right Ear
Left Ear
Legend
Masked
Reliability
Good
PTA (dB HL) / AI (%)
AC BC AI
Right 12 10 96
Left 10 10 84
Aud Method: Standard
Frequency (Hz) Right
Frequency (Hz) Left
AC
BC
Speech SDT SRT WRS / SRS 1 WRS / SRS 2 MCL UCL
Right 5 92.0 45
Left 5 88.0 45
Bin
Note 1 NU-6 List 3A 2 NU-6 List 2A
Aided
Note
Report Comments:

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	5 dB	0
Masker Alert	0 %	0
Trial Time	3.4 s	30
False Alarm	0 %	0
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌉	⌈

air	-5	-10	-10	-10	-10	-10	-10	RL
bone								RL
air	0	-10	-10	-5	-10	-5	LF
bone				40			LF

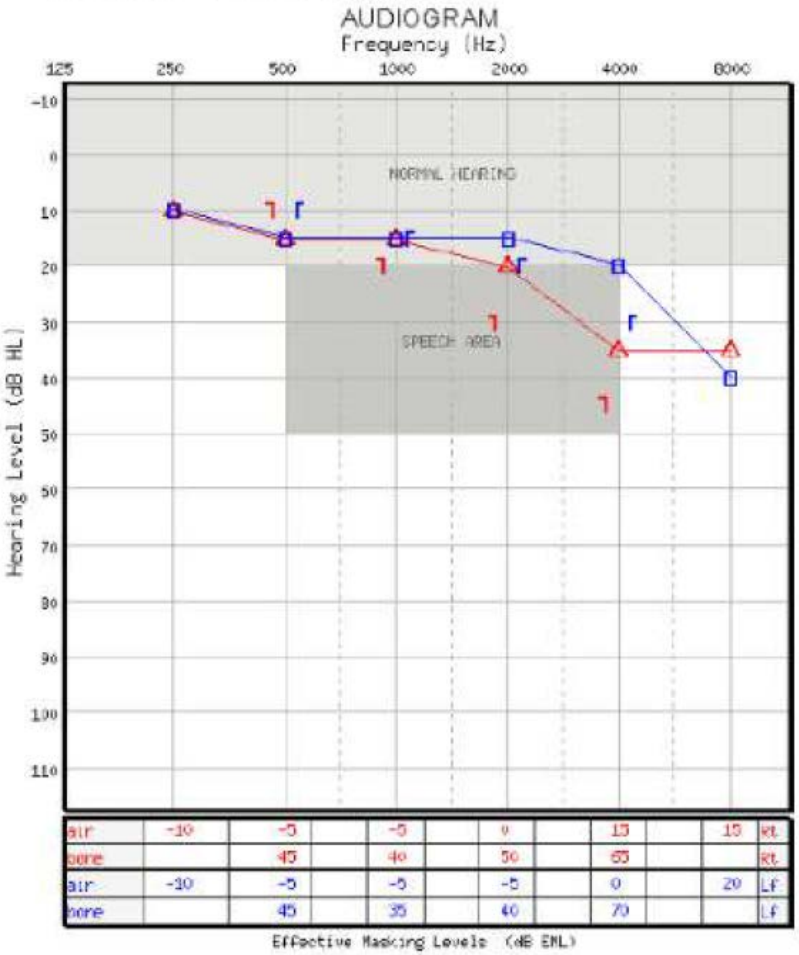
Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL		Cannot determine	Symmetric
Left	NORMAL		Cannot Determine	

Speech Recognition Report

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	5 dB	0
Masker Alert	0 %	0
Trial Time	3.4 s	30
False Alarm	0 %	0
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

GSI AMTAS™ Hearing Report



air	-10		-5		-5		0		10	Rt
bone			45		40		50			Rt
air	-10		-5		-5		-5		20	Lf
bone			45		35		40			Lf

Effective Masking Levels (dB EML)

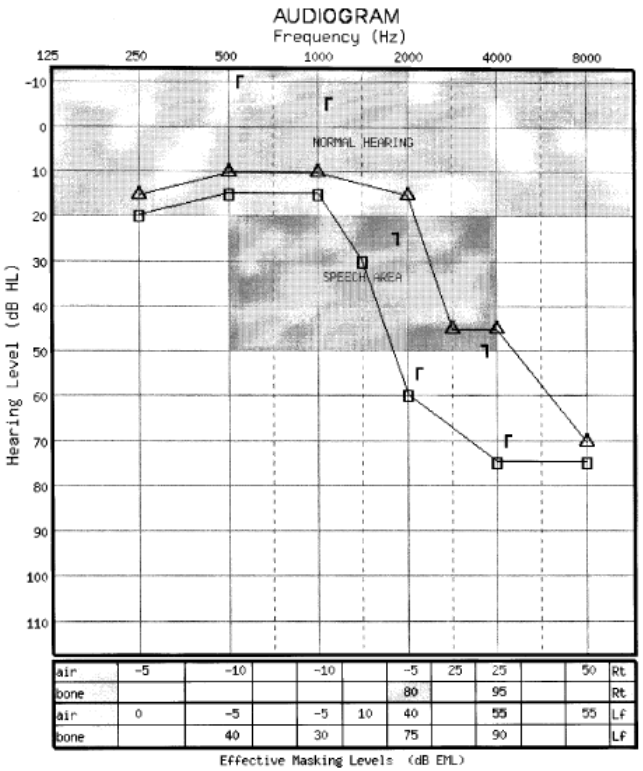
QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	20
Masker Alert	0 %	0
Trial Time	3.4 s	30
False Alarm	9 %	65
Test-Retest	3 dB	23
Check Fail	0 %	0
MBG > 35	0	0
MBG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌐	⌐

AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL-MILD	Sloping Hearing Loss	SENSORINEURAL	Symmetric
Left	MILD	Flat Hearing Loss	SENSORINEURAL	

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	20
Masker Alert	0 %	0
Trial Time	3.4 s	30
False Alarm	9 %	65
Test-Retest	3 dB	23
Check Fail	0 %	0
MBG > 35	0	0
MBG < -10	0	0

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	5
Masker Alert	5 %	70
Trial Time	4 s	70
False Alarm	0 %	0
Test-Retest	0 dB	0
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⅂	Γ
Over Masking		

air	-5		-10		-10		-5	25	25		50	Rt
bone							80		95			Rt
air	0		-5		-5	10	40		55		55	Lf
bone			40		30		75		90			Lf

Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL-MODERATE	Sloping Hearing Loss	SENSORINEURAL	Asymmetric
Left	NORMAL-SEVERE	Sloping Hearing Loss	MIXED	

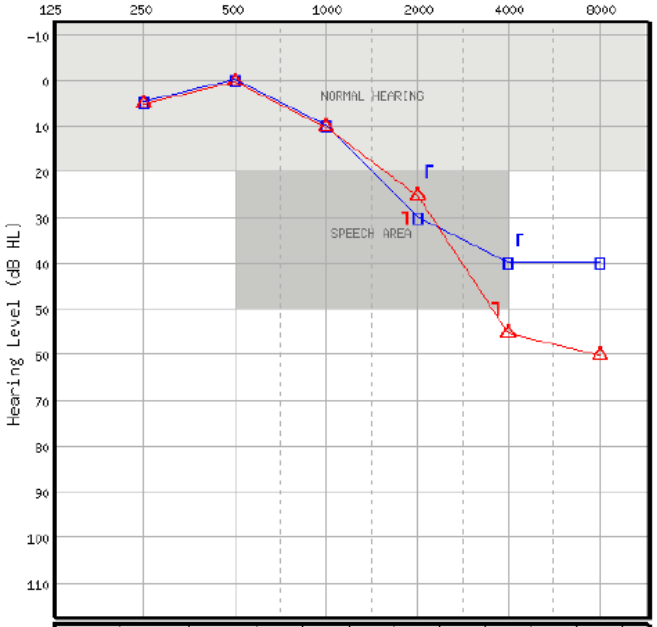
Speech Recognition Report											
Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	12	7	76	34	14	NU6-2	84	42	22	NU6-4
Left	15	15	64	37	17	NU6-1	76	45	25	NU6-3

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	5
Masker Alert	5 %	70
Trial Time	4 s	70
False Alarm	0 %	0
Test-Retest	0 dB	0
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⅂	Γ

GSI AMTAS™ Hearing Report

AUDIOGRAM



QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	7 dB	35
Masker Alert	0 %	0
Trial Time	3.4 s	35
False Alarm	14 %	80
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

air	-10		-10		-10		5		30	40	Rt
bone							50		75		Rt
air	-10		-10		-10		10		20	20	Lf
bone							45		90		Lf

Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL-MODERATE	Sloping Hearing Loss	SENSORINEURAL	Asymmetric
Left	NORMAL-MODERATE	Sloping Hearing Loss	SENSORINEURAL	

Speech Recognition Report

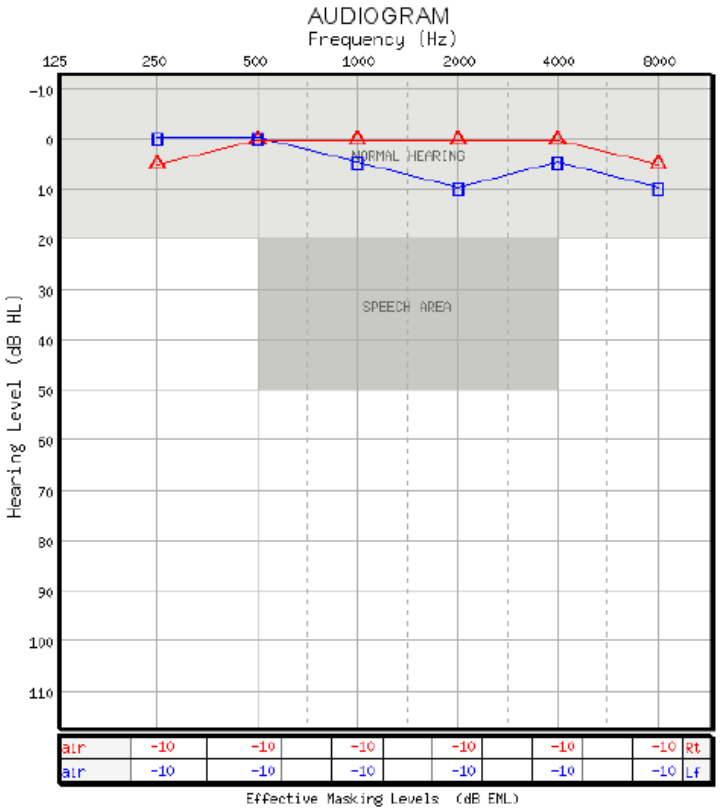
Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	5	-5	80	27	7	NU6-4	88	35	15	NU6-2
Left	5	-5	84	27	7	NU6-1	96	35	15	NU6-3

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	7 dB	35
Masker Alert	0 %	0
Trial Time	3.4 s	35
False Alarm	14 %	80
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

Speech Recognition Report

Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	5	-5	80	27	7	NU6-4	88	35	15	NU6-2
Left	5	-5	84	27	7	NU6-1	96	35	15	NU6-3

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	30
Trial Time	4.4 s	85
False Alarm	4 %	40
Test-Retest	3 dB	23
Check Fail	0 %	0

LEGEND	Right	Left
Masked Air	△	□

air	-10	-10		-10		-10		-10		-10	Rt
air	-10	-10		-10		-10		-10		-10	Lf

Effective Masking Levels (dB EML)

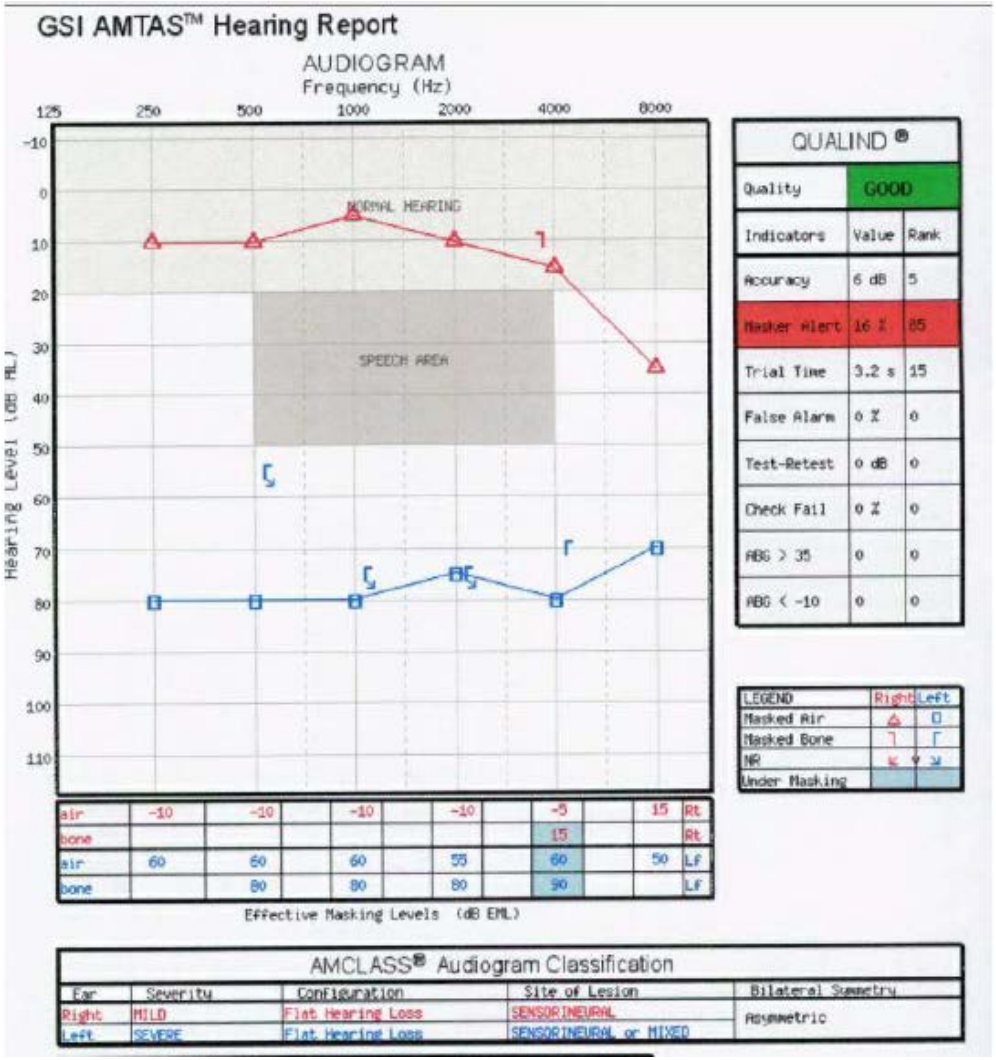
AMCLASS® Audiogram Classification

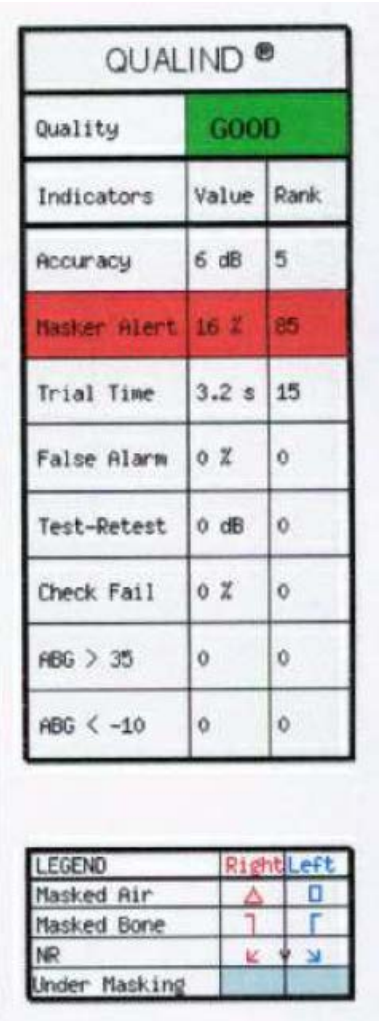
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL		Cannot determine	Symmetric
Left	NORMAL		Cannot determine	

Speech Recognition Report

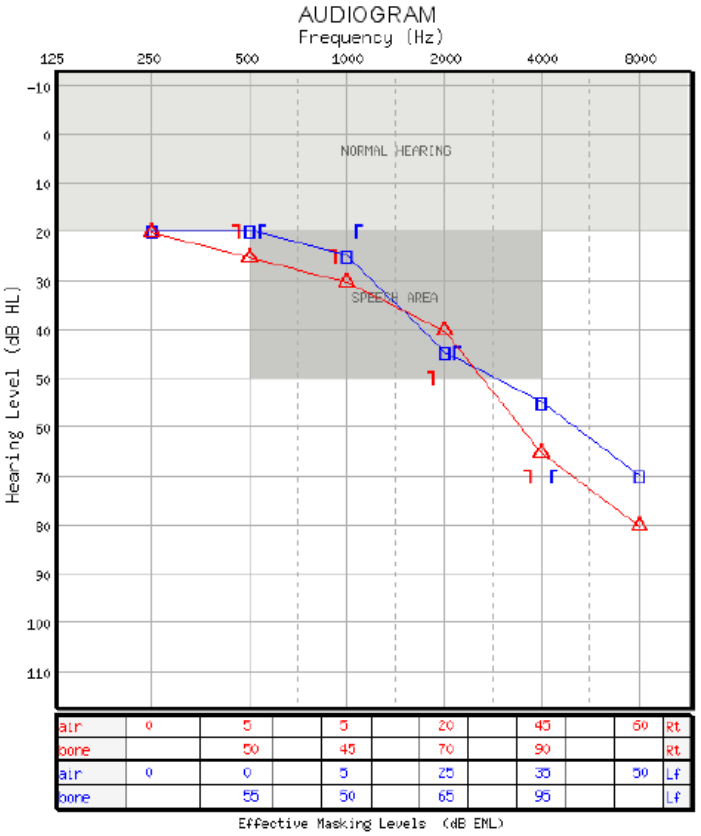
Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	0	-5	100	22	2	NU6-3
Left	5	-5	92	27	7	NU6-4

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	30
Trial Time	4.4 s	85
False Alarm	4 %	40
Test-Retest	3 dB	23
Check Fail	0 %	0


GSI AMTAS™ Hearing Report
AUDIOGRAM
Frequency (Hz)
125 250 500 1000 2000 4000 8000
Hearing Level (dB HL)
-10 0 10 20 30 40 50 60 70 80 90 100 110
NORMAL HEARING
SPEECH AREA
QUALIND ®
Quality GOOD
Indicators Value Rank
Accuracy 6 dB 5
Masker Alert 16 % 85
Trial Time 3.2 s 15
False Alarm 0 % 0
Test-Retest 0 dB 0
Check Fail 0 % 0
ABG > 35 0 0
ABG < -10 0 0
LEGEND Right Left
Masked Air
Masked Bone
NR
Under Masking
air -10 -10 -10 -10 -5 15 Rt
bone 15 Rt
air 60 60 60 55 60 50 Lf
bone 80 80 80 90 Lf
Effective Masking Levels (dB EML)
AMCLASS® Audiogram Classification
Ear Severity Configuration Site of Lesion Bilateral Symmetry
Right MILD Flat Hearing Loss SENSORINEURAL
Left SEVERE Flat Hearing Loss SENSORINEURAL or MIXED
Asymmetric


QUALIND ®
Quality GOOD
Indicators Value Rank
Accuracy 6 dB 5
Masker Alert 16 % 85
Trial Time 3.2 s 15
False Alarm 0 % 0
Test-Retest 0 dB 0
Check Fail 0 % 0
ABG > 35 0 0
ABG < -10 0 0
LEGEND Right Left
Masked Air
Masked Bone
NR
Under Masking

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	20
Masker Alert	0 %	0
Trial Time	4.3 s	80
False Alarm	3 %	30
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

air	0		5		5		20		45		50	Rt
bone			50		45		70		90			Rt
air	0		0		5		25		35		30	Lf
bone			55		50		65		95			Lf

Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	MILD-SEVERE	Sloping Hearing Loss	SENSORINEURAL	Symmetric
Left	MILD-SEVERE	Sloping Hearing Loss	SENSORINEURAL	

Speech Recognition Report

Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	32	7	92	54	34	NU6-2
Left	23	28	88	45	25	NU6-4

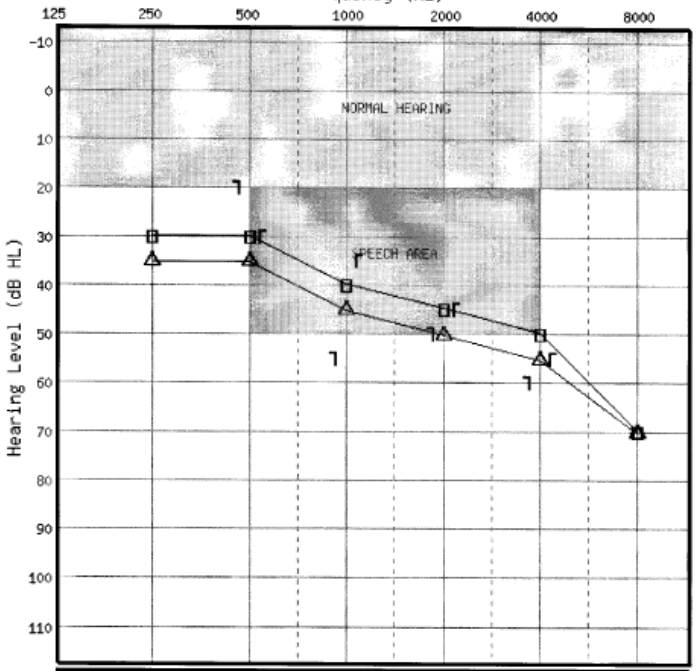
QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	20
Masker Alert	0 %	0
Trial Time	4.3 s	80
False Alarm	3 %	30
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

GSI AMTAS™ Hearing Report

AUDIOGRAM

Frequency (Hz)



QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	30
Masker Alert	0 %	0
Trial Time	3.9 s	65
False Alarm	6 %	50
Test-Retest	0 dB	0
Check Fail	5-1	65
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

air	15	15	25	30	35	50	Rt
bone		60	75	70	85		Rt
air	10	10	20	25	30	50	Lf
bone		65	65	70	90		Lf

Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	MILD-SEVERE	Sloping Hearing Loss	SENSORINEURAL	Symmetric
Left	MILD-MODERATE	Sloping Hearing Loss	SENSORINEURAL	

Speech Recognition Report

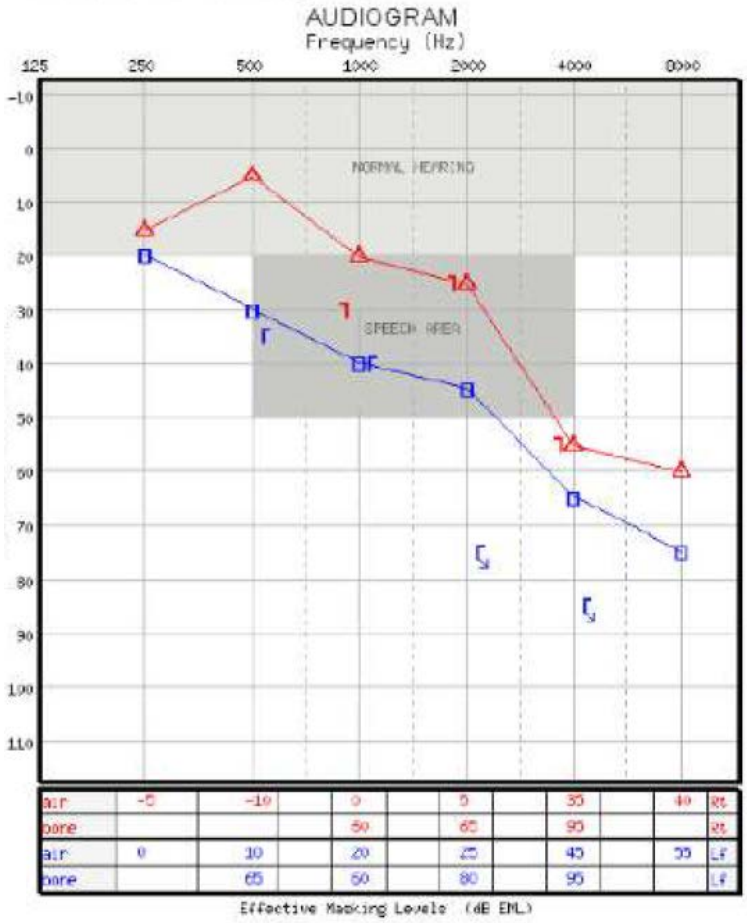
Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	43	43	88	65	45	NU6-2				
Left	38	33	80	60	40	NU6-4	80	68	48	NU6-1

QUALIND ®		
Quality	GOOD	
Indicators	Value	Rank
Accuracy	6 dB	30
Masker Alert	0 %	0
Trial Time	3.9 s	65
False Alarm	6 %	50
Test-Retest	0 dB	0
Check Fail	5-1	65
ABG > 35	0	0
ABG < -10	0	0

Speech Recognition Report

Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	43	43	88	65	45	NU6-2				
Left	38	33	80	60	40	NU6-4	80	68	48	NU6-1

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	8 dB	55
Masker Alert	0 %	0
Trial Time	4.6 s	90
False Alarm	10 %	70
Test-Retest	5 dB	45
Check Fail	0 %	0
ABG > 30	0	0
ABG < -10	1	50

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌉	⌈
NR	↳	↲

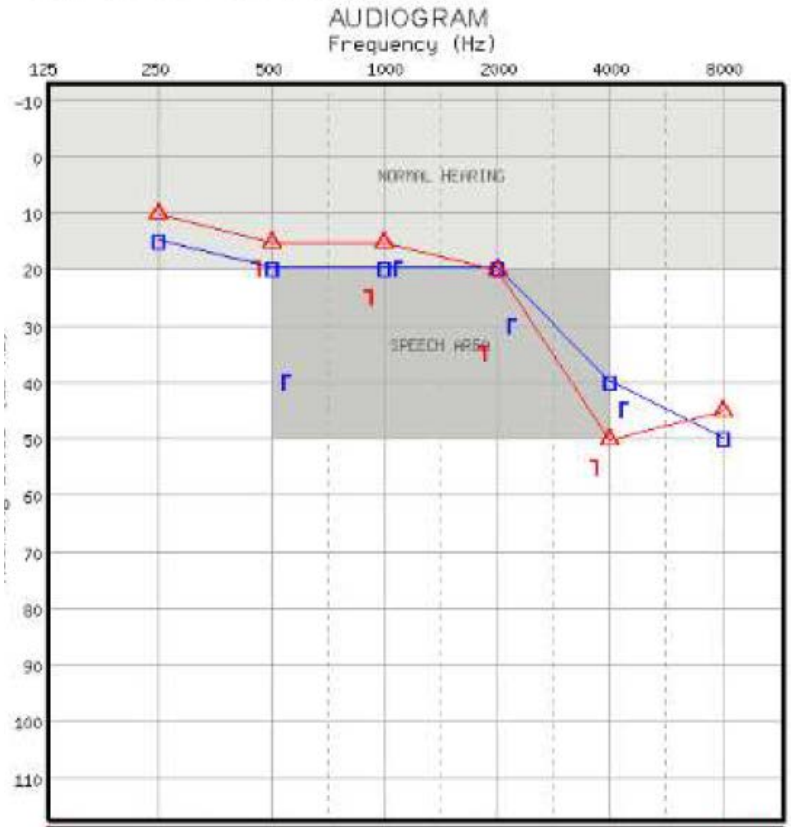
Air	-5	-10	0	5	35	40	dB
Bone			50	65	90		dB
Air	0	10	20	25	45	55	LF
Bone		65	50	80	95		LF

Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL-MODERATE	Sloping Hearing Loss	SENSORINEURAL	Asymmetric
Left	MILD-SEVERE	Sloping Hearing Loss	SENSORINEURAL	

QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	8 dB	55
Masker Alert	0 %	0
Trial Time	4.6 s	90
False Alarm	10 %	70
Test-Retest	5 dB	45
Check Fail	0 %	0
ABG > 30	0	0
ABG < -10	1	50

GSI AMIAS™ Hearing Report



QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	8 dB	60
Masker Alert	0 %	0
Trial Time	5.4 s	95
False Alarm	3 %	25
Test-Retest	5 dB	46
Check Fail	5 %	85
ABG > 35	0	0
ABG < -10	2	80

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

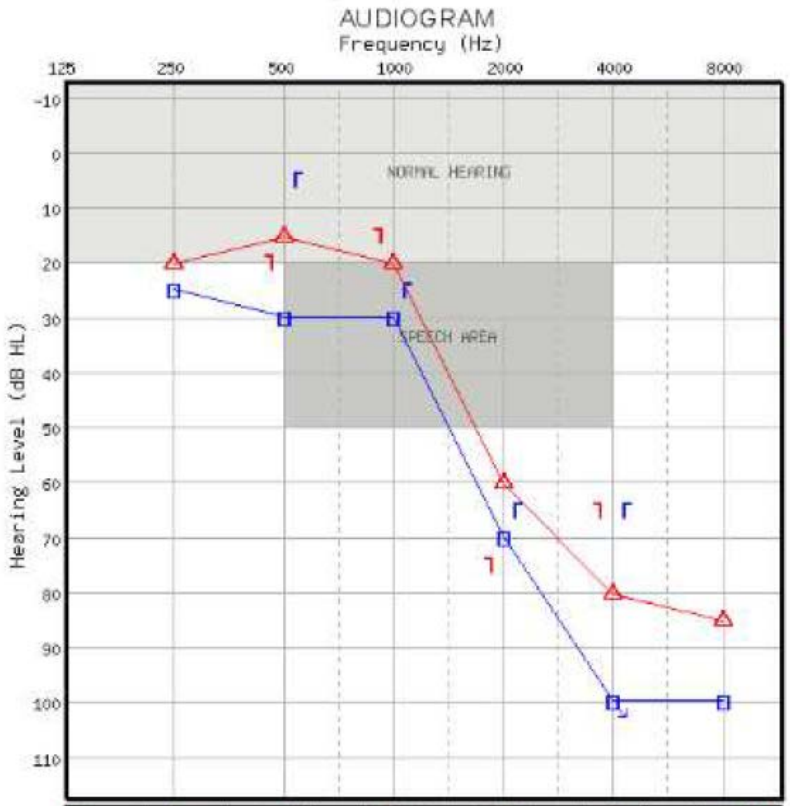
air	-10		-5		0		0		30	25	Rt
bone			50		45		55		75		Rt
air	-5		0		0		0		20	30	Lf
bone			70		40		50		85		Lf

Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL-MODERATE	Sloping Hearing Loss	SENSORINEURAL	Symmetric
Left	NORMAL-MODERATE	Sloping Hearing Loss	SENSORINEURAL	

QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	8 dB	60
Masker Alert	0 %	0
Trial Time	5.4 s	95
False Alarm	3 %	25
Test-Retest	5 dB	46
Check Fail	5 %	85
ABG > 35	0	0
ABG < -10	2	80

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	7 dB	50
Masker Alert	9 %	80
Trial Time	3.2 s	15
False Alarm	4 %	35
Test-Retest	0 dB	0
Check Fail	0 %	0
ABG > 35	1	70
ABG < -10	1	50

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌉	⌈
NR	⌞	⌟
Under Masking		

air	0	-5	0	40	60	65	Rt
bone		60	50	80	15		Rt
air	5	10	10	50	80	80	Lf
bone		45	45	80	15		Lf

Effective Masking Levels (dB EML)

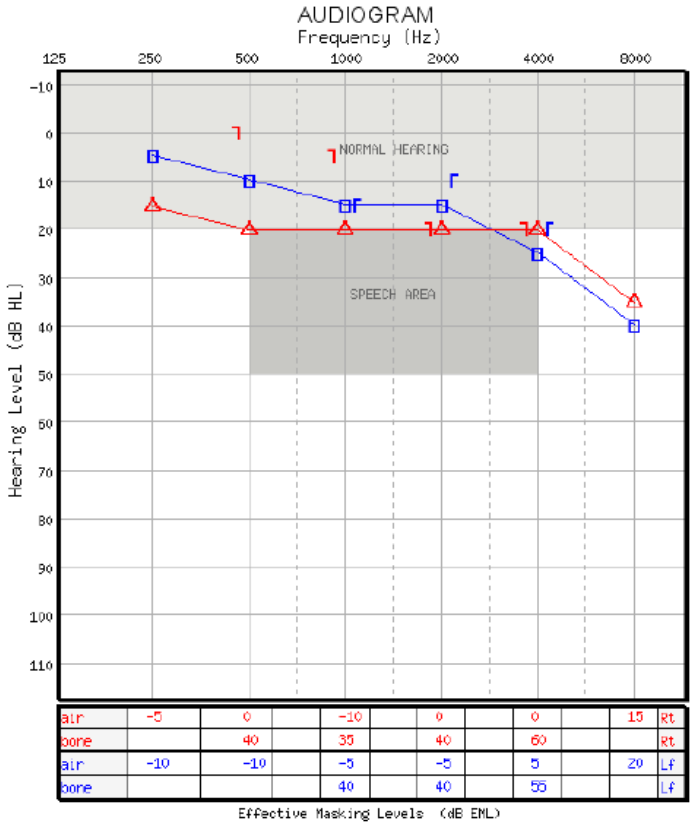
AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL-SEVERE	Sloping Hearing Loss	SENSORINEURAL	Asymmetric
Left	MILD-SEVERE	Sloping Hearing Loss	MIXED	

QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	7 dB	50
Masker Alert	9 %	80
Trial Time	3.2 s	15
False Alarm	4 %	35
Test-Retest	0 dB	0
Check Fail	0 %	0
ABG > 35	1	70
ABG < -10	1	50

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌉	⌈
NR	⌞	⌟
Under Masking		

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	7 dB	45
Masker Alert	0 %	0
Trial Time	3.2 s	15
False Alarm	10 %	65
Test-Retest	18 dB	100
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

Air	-5		0		-10		0		15	Rt
Bone			40		35		40		60	Rt
Air	-10		-10		-5		5		20	Lf
Bone					40		40		55	Lf

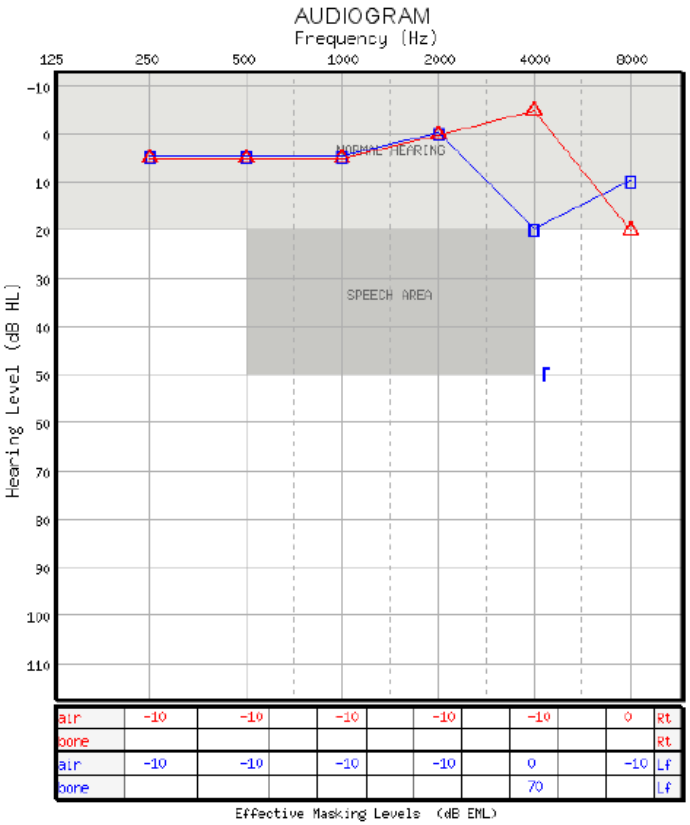
Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	MILD	Flat Hearing Loss	CONDUCTIVE	Symmetric
Left	NORMAL-MILD	Sloping Hearing Loss	SENSORINEURAL	

Speech Recognition Report						
Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	20	10	96	42	22	NU6-4
Left	13	8	96	35	15	NU6-3

QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	7 dB	45
Masker Alert	0 %	0
Trial Time	3.2 s	15
False Alarm	10 %	65
Test-Retest	18 dB	100
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	0	0

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	7 dB	45
Masker Alert	0 %	0
Trial Time	3.2 s	15
False Alarm	9 %	65
Test-Retest	5 dB	46
Check Fail	7 %	90
ABG > 35	0	0
ABG < -10	1	50

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌉	⌈

air	-10		-10		-10		-10		0	Rt
bone										Rt
air	-10		-10		-10		0		-10	Lf
bone							70			Lf

Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL		Cannot determine	Asymmetric
Left	NORMAL		Cannot Determine	

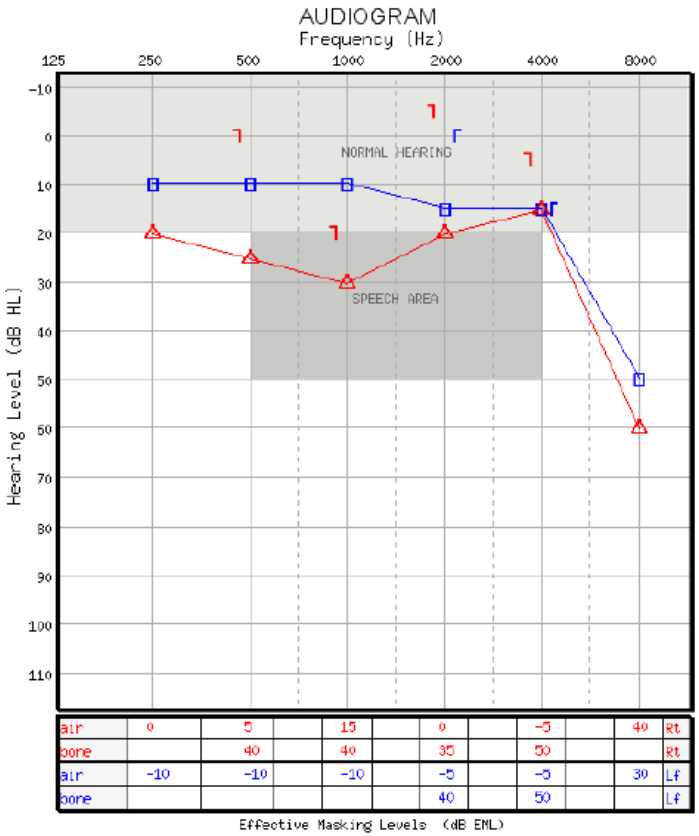
Speech Recognition Report

Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	3	-2	96	25	5	NU6-3
Left	3	-7	92	25	5	NU6-1

QUALIND ®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	7 dB	45
Masker Alert	0 %	0
Trial Time	3.2 s	15
False Alarm	9 %	65
Test-Retest	5 dB	46
Check Fail	7 %	90
ABG > 35	0	0
ABG < -10	1	50

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌉	⌈

GSI AMTAS™ Hearing Report



QUALIND ®	
Quality	FAIR

Indicators	Value	Rank
Accuracy	8 dB	55
Masker Alert	0 %	0
Trial Time	3.7 s	55
False Alarm	14 %	75
Test-Retest	5 dB	46
Check Fail	5 %	85
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

air	0		5		15		0	-5		40	Rt
bone			40		40		35	50			Rt
air	-10		-10		-10		-5	-5		30	Lf
bone							40	50			Lf

Effective Masking Levels (dB EML)

AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	MILD	Flat Hearing Loss	CONDUCTIVE	Asymmetric
Left	NORMAL-MILD	Sloping Hearing Loss	CONDUCTIVE	

Speech Recognition Report

Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	25	20	92	47	27	NU6-4				
Left	12	12	80	34	14	NU6-2	96	42	22	NU6-3

QUALIND ®	
Quality	FAIR

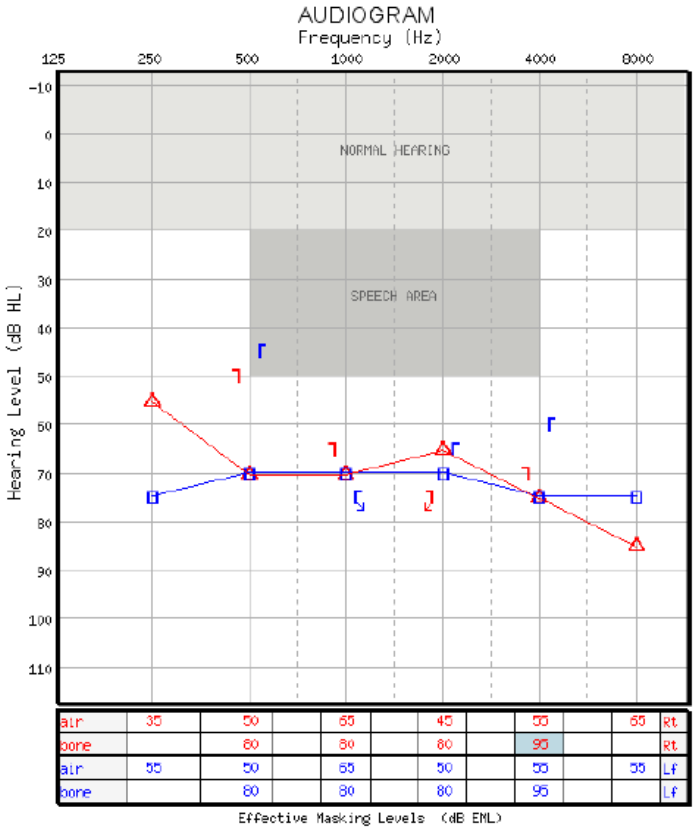
Indicators	Value	Rank
Accuracy	8 dB	55
Masker Alert	0 %	0
Trial Time	3.7 s	55
False Alarm	14 %	75
Test-Retest	5 dB	46
Check Fail	5 %	85
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

Speech Recognition Report

Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	25	20	92	47	27	NU6-4				
Left	12	12	80	34	14	NU6-2	96	42	22	NU6-3

GSI AMTAS™ Hearing Report



air	35		50		55		45		55		60	Rt
bone			80		80		80		90			Rt
air	55		50		55		50		55		55	Lf
bone			80		80		80		95			Lf

Effective Masking Levels (dB EML)

QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	14 dB	90
Masker Alert	5 %	70
Trial Time	4.2 s	75
False Alarm	0 %	0
Test-Retest	15 dB	100
Check Fail	68 %	100
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜
NR	↙ ↓ ↘	
Under Masking		

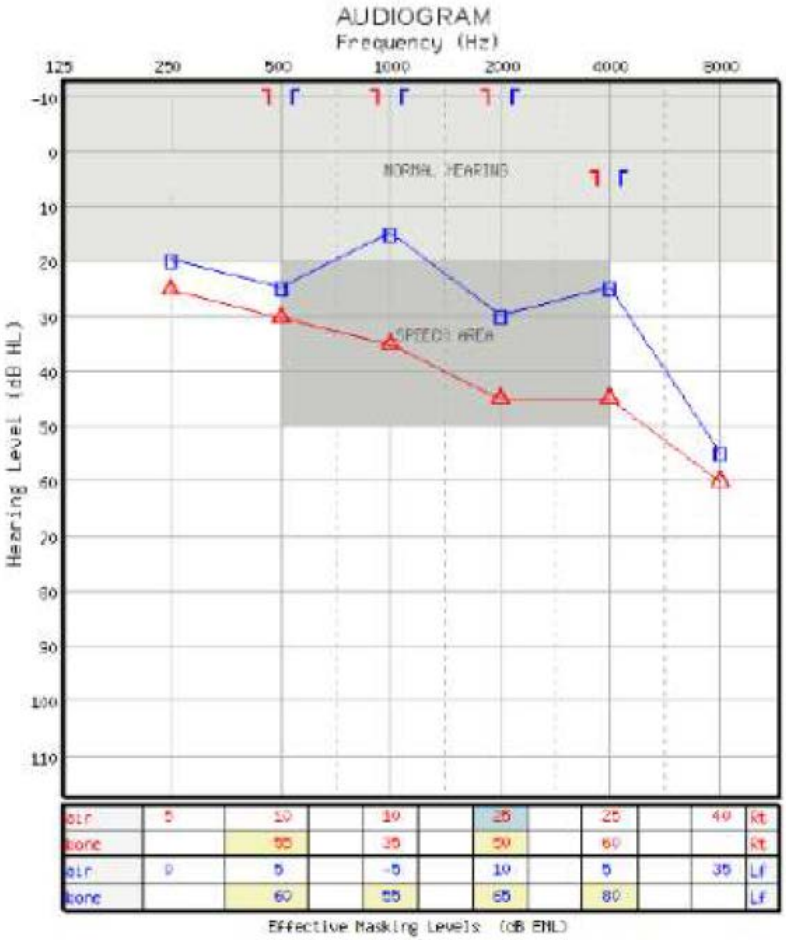
AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	SEVERE	Flat Hearing Loss	MIXED	Asymmetric
Left	SEVERE	Flat Hearing Loss	MIXED	

PTA	
Ear	dB HL
Right	68
Left	70

QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	14 dB	90
Masker Alert	5 %	70
Trial Time	4.2 s	75
False Alarm	0 %	0
Test-Retest	15 dB	100
Check Fail	68 %	100
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜
NR	↙ ↓ ↘	
Under Masking		

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	18 dB	95
Masker Alert	32 %	90
Trial Time	4.2 s	75
False Alarm	42 %	100
Test-Retest	3 dB	23
Check Fail	0 %	0
ABS > 35	5	93
ABS < -10	6	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌉	⌈
Over Masking		
Under Masking		

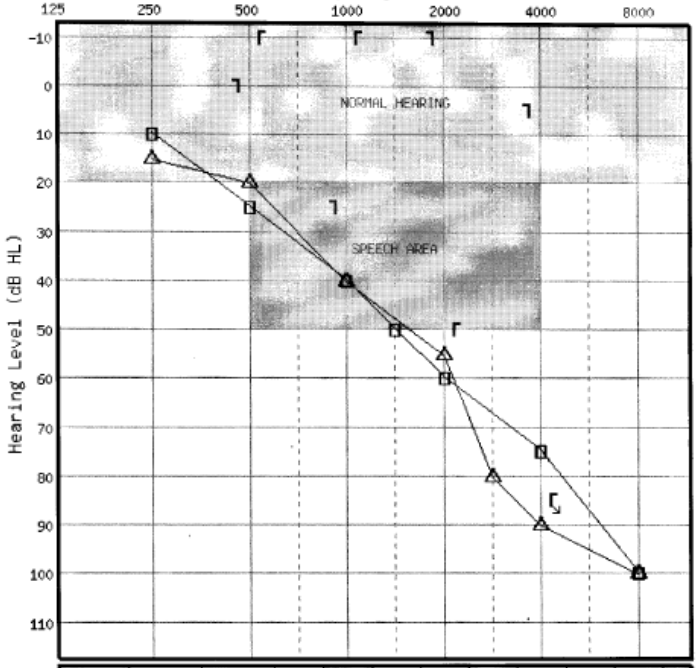
AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symetry
Right	MILD-MODERATE	Sloping Hearing Loss	CONDUCTIVE	Asymmetric

QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	18 dB	95
Masker Alert	32 %	90
Trial Time	4.2 s	75
False Alarm	42 %	100
Test-Retest	3 dB	23
Check Fail	0 %	0
ABS > 35	5	93
ABS < -10	6	0

GSI AMTAS™ Hearing Report

AUDIOGRAM

Frequency (Hz)



air	-5	0		20		35	60	70		80	Rt
bone		55		60		80		95			Rt
air	-10	5		20	30	40		55		80	Lf
bone		50		60		75		15			Lf

Effective Masking Levels (dB EML)

QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	13 dB	90
Masker Alert	38 %	95
Trial Time	3.8 s	60
False Alarm	19 %	85
Test-Retest	0 dB	0
Check Fail	0 %	0
ABG > 50	3	89
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜
NR	↙	↘
Over Masking		
Under Masking		

AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	MILD-SEVERE	Sloping Hearing Loss	CONDUCTIVE	Symmetric
Left	MILD-SEVERE	Sloping Hearing Loss	MIXED	

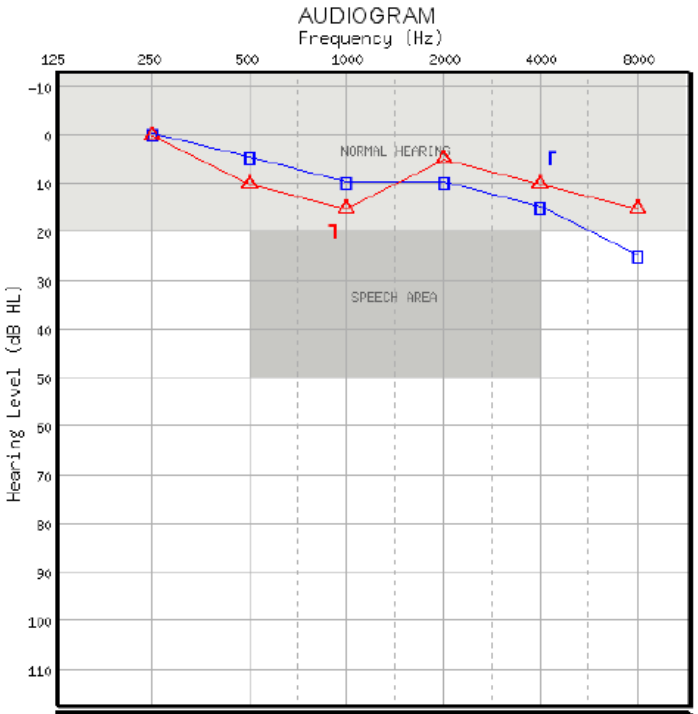
Speech Recognition Report

Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	30	20	68	52	32	NU6-1	40	60	40	NU6-2
Left	33	23	44	55	35	NU6-4	64	63	43	NU6-3

QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	13 dB	90
Masker Alert	38 %	95
Trial Time	3.8 s	60
False Alarm	19 %	85
Test-Retest	0 dB	0
Check Fail	0 %	0
ABG > 50	3	89
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜
NR	↙	↘
Over Masking		
Under Masking		

GSI AMTAS™ Hearing Report



QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	11 dB	85
Masker Alert	0 %	0
Trial Time	4 s	70
False Alarm	14 %	80
Test-Retest	0 dB	0
Check Fail	44 %	100
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

air	-10		-10		-5		-10		-10		-5	Rt
bone					40							Rt
air	-10		-10		-10		-10		-5		5	Lf
bone									45			Lf

Effective Masking Levels (dB EML)

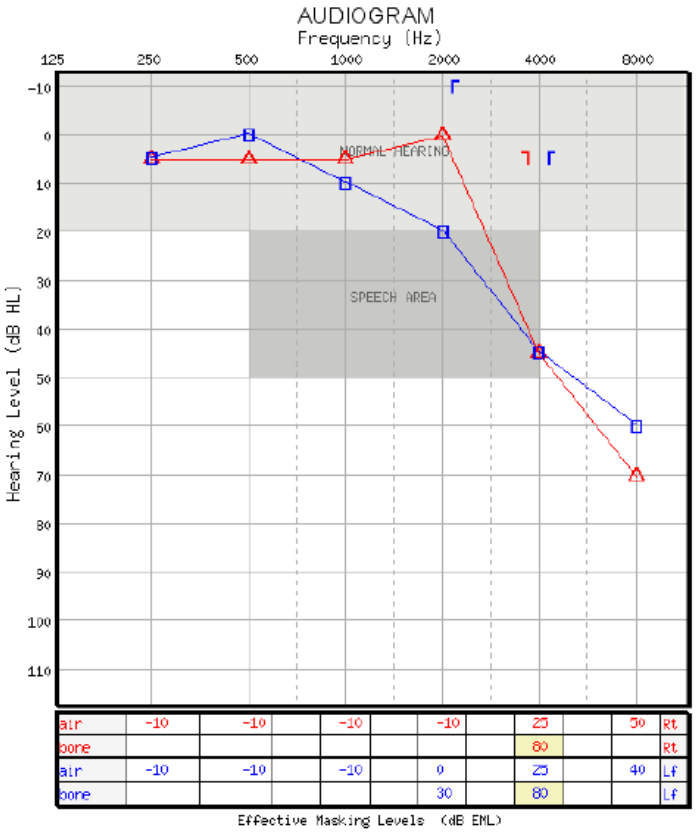
AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL		Cannot Determine	Symmetric
Left	NORMAL		Cannot Determine	

Speech Recognition Report						
Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	10	5	92	32	12	NU6-4
Left	8	-2	88	30	10	NU6-1

QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	11 dB	85
Masker Alert	0 %	0
Trial Time	4 s	70
False Alarm	14 %	80
Test-Retest	0 dB	0
Check Fail	44 %	100
ABG > 35	0	0
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜

AMTAS™ Hearing Report



Air	-10		-10		-10		25		50	Rt
Bone							60			Rt
Air	-10		-10		0		25		40	Lf
Bone					30		80			Lf

Effective Masking Levels (dB EML)

QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	12 dB	65
Masker Alert	12 %	65
Trial Time	4 s	70
False Alarm	26 %	90
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	2	65
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜
Over Masking		

AMCLASS® Audiogram Classification

Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL-MODERATE	Sloping Hearing Loss	CONDUCTIVE	Asymmetric
Left	NORMAL-MODERATE	Sloping Hearing Loss	CONDUCTIVE	

Speech Recognition Report

Ear	PTA dB HL	SRT dB HL	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List	Word Recognition (NU6 closed set) Correct %	Level dB HL	Mask dB HL	List
Right	3	-2	76	25	5	NU6-2	92	33	13	NU6-3
Left	10	5	84	32	12	NU6-4	84	40	20	NU6-1

QUALIND ®		
Quality	POOR	
Indicators	Value	Rank
Accuracy	12 dB	65
Masker Alert	12 %	65
Trial Time	4 s	70
False Alarm	26 %	90
Test-Retest	3 dB	23
Check Fail	0 %	0
ABG > 35	2	65
ABG < -10	0	0

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	⌝	⌜
Over Masking		

AMTAS Automated Audiometry

- Does not replace audiologists.
- Interpretation and intervention requires skillset of experienced audiologist
- Quality indicators give confidence in results

Enhancements in the queue:

- Non-ear specific bone conduction
  - Performed first
  - No masking
  - Reduce errors in responding to masking noise
  - If asymmetry, will re-test bone with masking
- Non-linguistic speech testing
  - Does not require literacy
  - Does not depend on English as first language

DESIGNED
SMART
BUILT
STRONG