

1. This document was created to support maximum accessibility for all learners. If you would like to print a hard copy of this document, please follow the general instructions below to print multiple slides on a single page or in black and white.
2. This handout is for reference only. Non-essential images have been removed for your convenience. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.
3. Copyright: Images used in this course are used in compliance with copyright laws and where required, permission has been secured to use the images in this course. All use of these images outside of this course may be in violation of copyright laws and is strictly prohibited.
4. Social Workers: For additional information regarding standards and indicators for cultural competence, please review the NASW resource: [Standards and Indicators for Cultural Competence in Social Work Practice](#)
5. Need Help? Select the “Help” option in the member dashboard to access FAQs or contact us.

How to Print Handouts

- On a Mac
 - Open PDF in Preview
 - Click File
 - Click Print
 - Click dropdown menu on the right “preview”
 - Click layout
 - Choose # of pages per sheet from dropdown menu
 - Checkmark Black & White if wanted.
- On a PC
 - Open PDF
 - Click Print
 - Choose # of pages per sheet from dropdown menu
 - Choose Black and White from “Color” dropdown

No part of the materials available through the continued.com site may be copied, photocopied, reproduced, translated or reduced to any electronic medium or machine-readable form, in whole or in part, without prior written consent of continued.com, LLC. Any other reproduction in any form without such written permission is prohibited. All materials contained on this site are protected by United States copyright law and may not be reproduced, distributed, transmitted, displayed, published or broadcast without the prior written permission of continued.com, LLC. Users must not access or use for any commercial purposes any part of the site or any services or materials available through the site.





Teleaudiology: Advancing Access and Equity in Hearing Care

Part I: Hearing Care in the 21st Century

Presented in partnership with Salus University

Aaron Roman, AuD

Samantha Kleindienst Robler, AuD, PhD



Aaron Roman, AuD

Aaron M. Roman is an Assistant Professor at Salus University in Philadelphia, Pennsylvania. He received his B.A., M.A., and Au.D. from the University of Pittsburgh. Dr. Roman's has clinical expertise in auditory processing across the lifespan, cognitive screening protocols, and aural rehabilitation for individuals with cochlear implants. His research interests include assessing the impact of hearing loss on cognitive impairment as well as evaluating hearing loss assessment programs, including newborn hearing screening programs. His work has been disseminated through peer-reviewed publications and local, national, and international presentations.



Samantha Kleindienst Robler, AuD, PhD

Samantha Kleindienst Robler, AuD, PhD, is an assistant professor and researcher at the University of Arkansas for Medical Sciences in Little Rock, AR, and a part time audiologist and population health researcher for Norton Sound Health Corporation in Nome, AK. Her clinical and research interests include innovating and improving tools that address accessibility to hearing

healthcare, including development and application of telemedicine technology in the clinic, as well as addressing global hearing health and public policy in the hearing healthcare delivery system.

Disclosures

- **Presenter Disclosures:** Financial: Aaron Roman is employed by Salus University. He received an honorarium for presenting this course. Non-financial: Aaron Roman has no relevant non-financial relationships to disclose. Financial: Samantha Kleindienst Robler is employed by the University of Arkansas for Medical Sciences and Norton Sound Health Corporation. She received an honorarium for presenting this course. Non-financial: Samantha Kleindienst Robler is on the board of directors for the American Academy of Audiology.
- **Content Disclosure:** This learning event does not focus exclusively on any specific product or service.
- **Sponsor Disclosure:** This course is presented by AudiologyOnline in partnership with Salus University.

Learning Outcomes

After this course, participants will be able to:

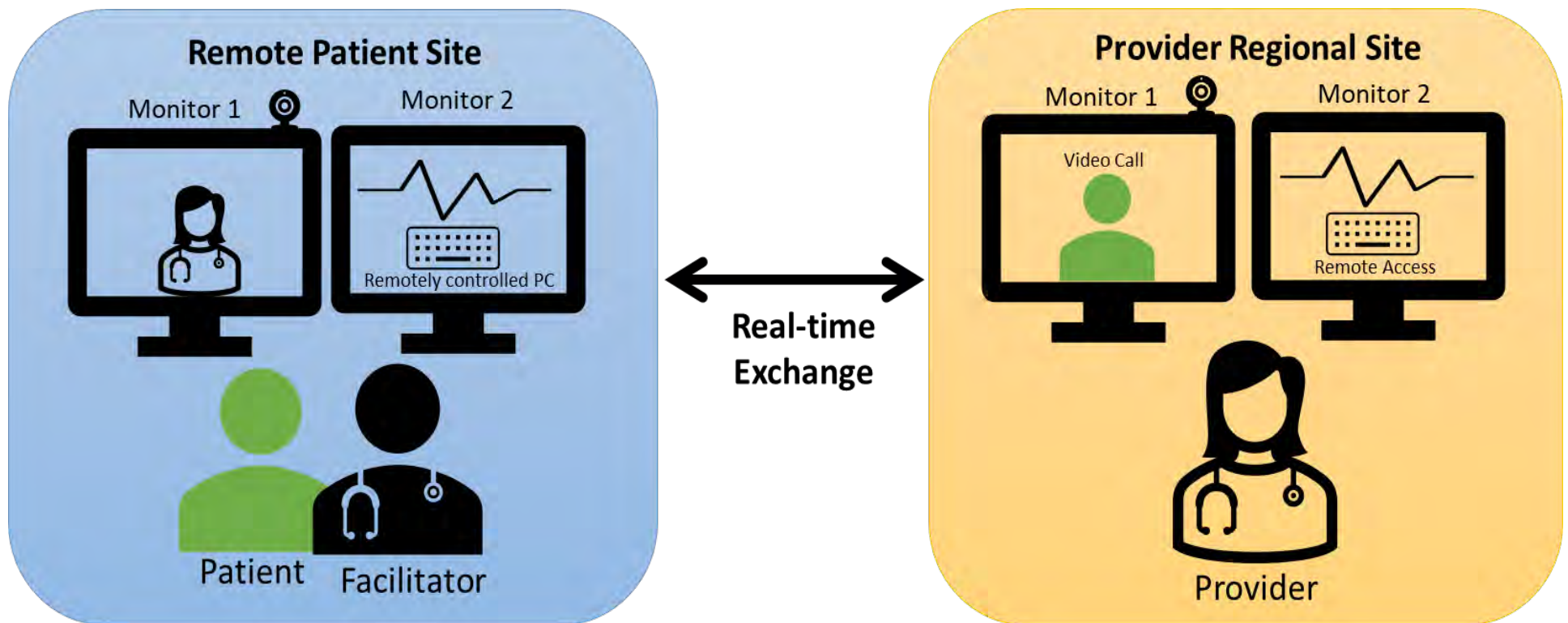
1. Describe technology solutions for teleaudiology.
2. Describe the factors that suggest the need for teleaudiology service delivery.
3. Identify approaches to the implementation of teleaudiology service delivery.

INTRODUCTION

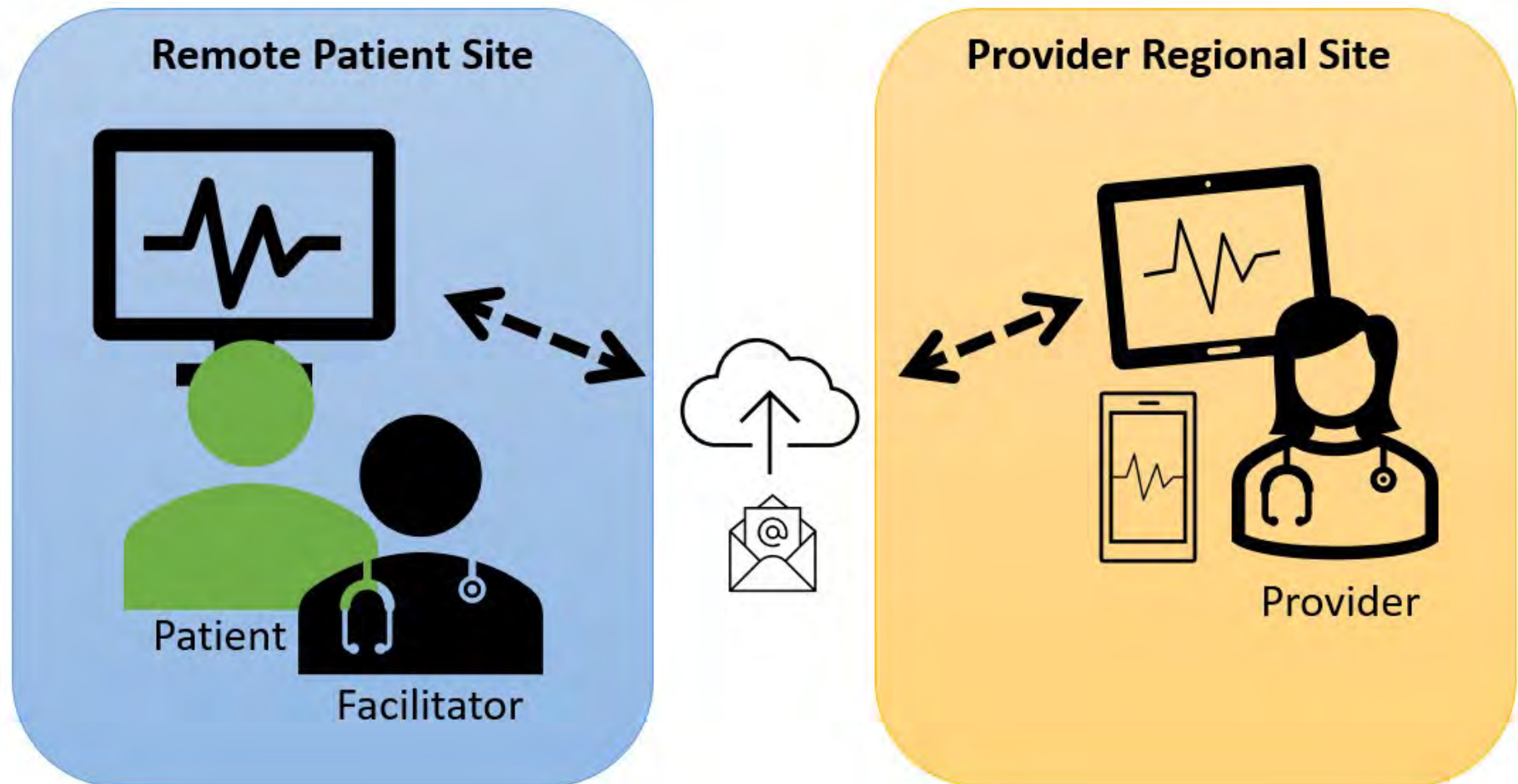
Teleaudiology: An Overview

- Service delivery at a distance
- Models
 - Synchronous
 - Asynchronous
 - Hybrid
 - Self-administered

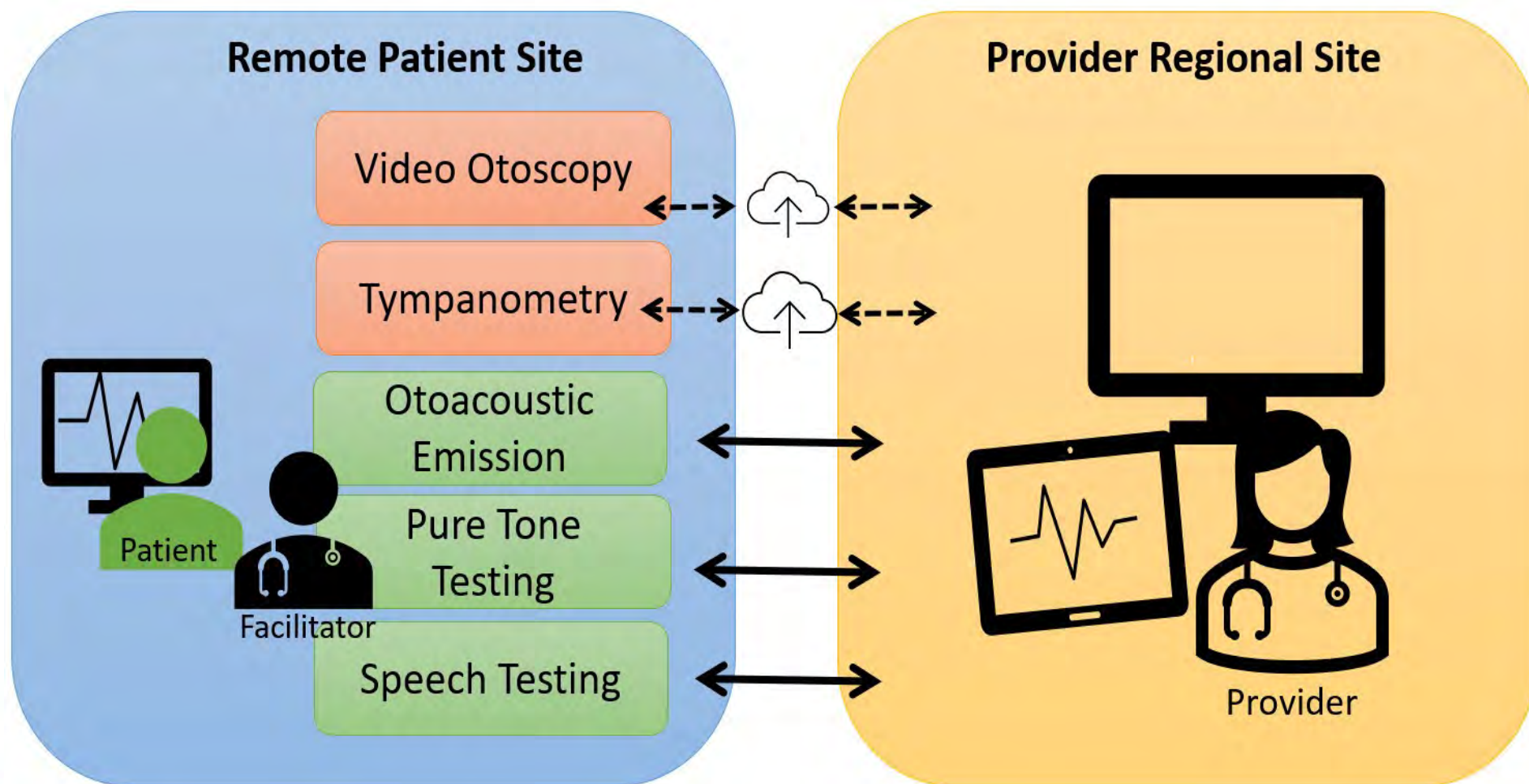
Telehealth: Synchronous



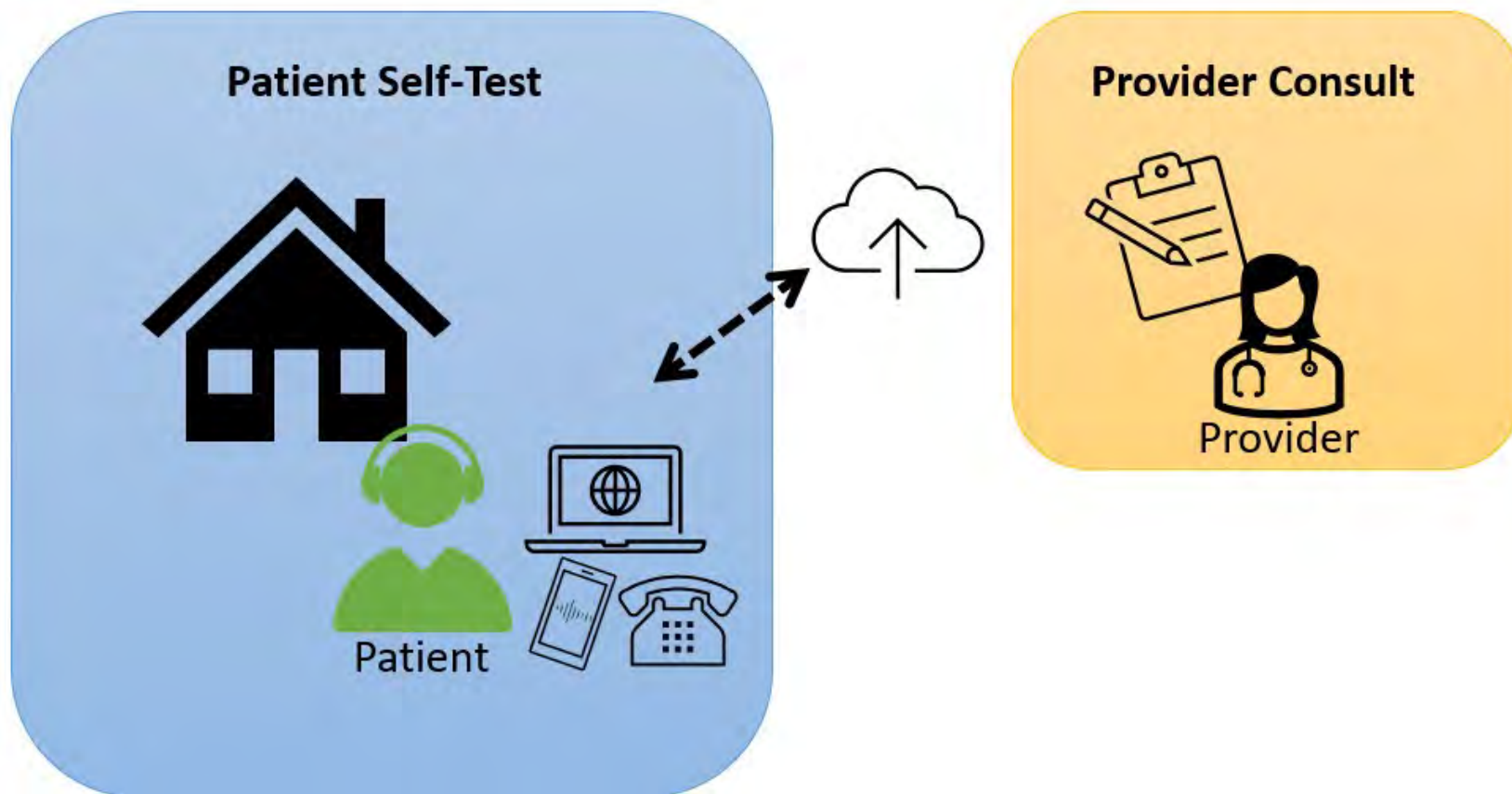
Telehealth: Asynchronous



Telehealth: Hybrid



Telehealth: Self-Administered



HISTORY OF TELEAUDIOLOGY

History of Teleaudiology

- Began in the 1990s



Barriers to Adoption

- Technology/infrastructure
- Provider/patient confidence
- Training limitations
- Privacy and security concerns
- Reimbursement/license

Teleaudiology & the Pandemic

Question	Yes %	No %
Did your workplace use any form of tele-audiology service delivery before COVID-19?	58	42
Are you using any form of tele-audiology service delivery now?	76	24
Do you think you will continue to use telehealth post COVID-19?	84	16

Bennett et al. 2020

Post-Pandemic

- Reliable and effective
- Some barriers have returned
- Under-utilization of teleaudiology despite provider comfort with remote services
- Future development and technology advancements

Back to the Future



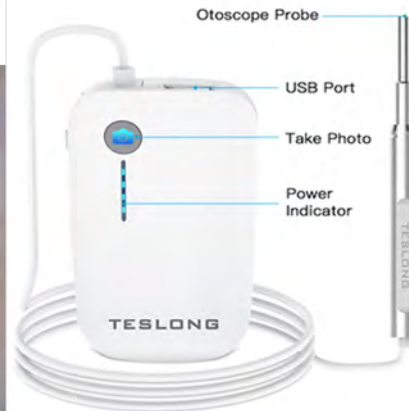
CURRENT STATE OF TELEAUDIOLOGY

Current State of the Art

- Robler, S. K., Coco, L., & Krumm, M. (2022). Telehealth solutions for assessing auditory outcomes related to noise and ototoxic exposures in clinic and research. *The Journal of the Acoustical Society of America*, 152(3), 1737-1754.

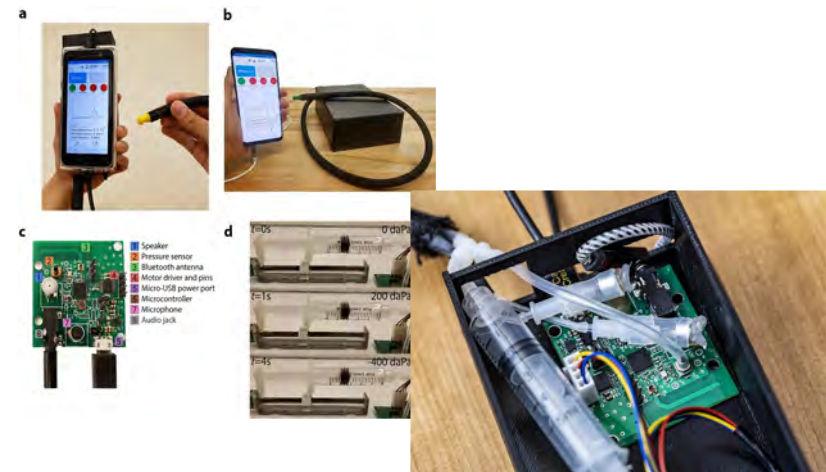
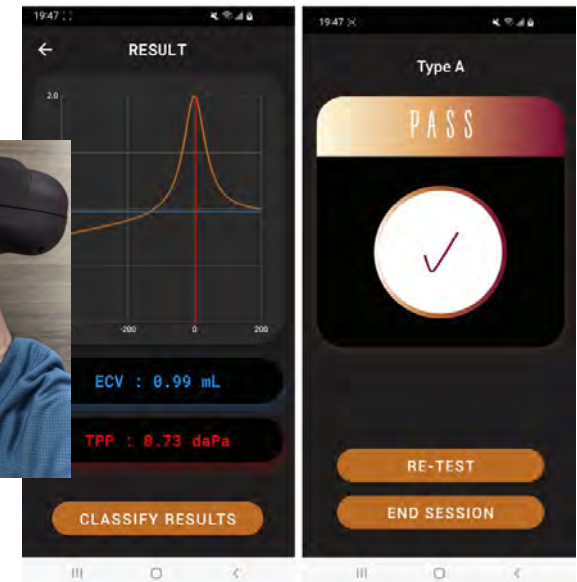
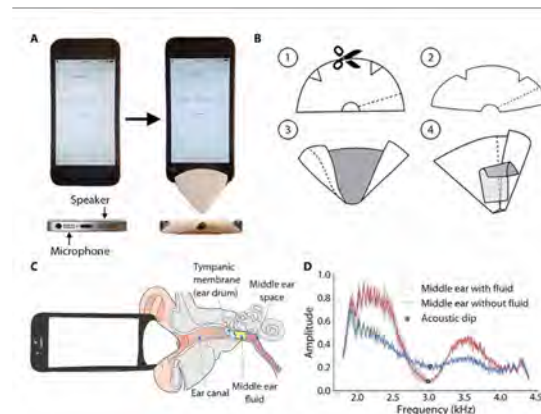
Otoscopy

- Smartphone/Mobile
- PC-based



Tympanometry/Spectrometry

- PC-based
- Smartphone
 - Chan et al 2019
 - Chan et al 2022
 - [mHealth Tympanometer](#)



Hearing Diagnostics



- Professional Portable Diagnostic Models
 - Smartphone/Tablet
 - Kiosk/Mobile
- PC-based Audiometers



Teleaudiology Hearing Diagnostics

Validity of Automated Air Conduction

- Overall average differences between manual and automated air conduction audiometry

0.4 dB, 6.1 SD

- Test-retest differences:
 - Manual = 1.3 dB, 6.1 SD
 - Automated = 0.3 dB, 6.9 SD

Teleaudiology Hearing Diagnostics

Validity of Automated Bone Conduction

- Accuracy: overall difference compared to manual testing in booth
- Test-retest reliability: overall difference for automated

0 dB, 7.7 SD

-0.2 dB, 4.5 SD

Teleaudiology Hearing Diagnostics

- Online machine learning audiometry compared to conventional threshold audiometry

- Mean difference between methods

3.24 dB, 5.15 SD

- Mean difference between repeated measures

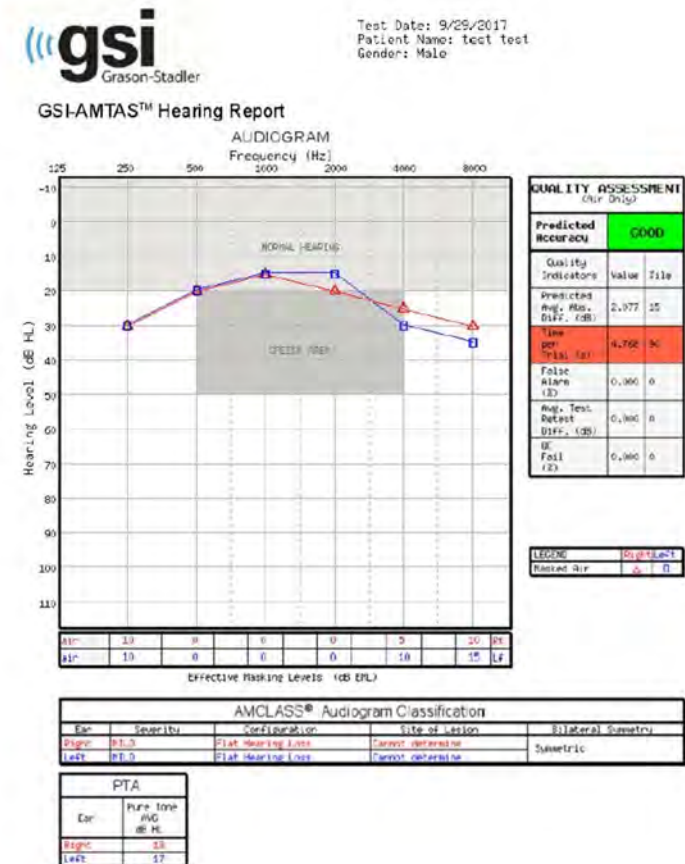
ML

2.85 dB, 6.57 SD

Conventional

1.88 dB, 3.56 SD

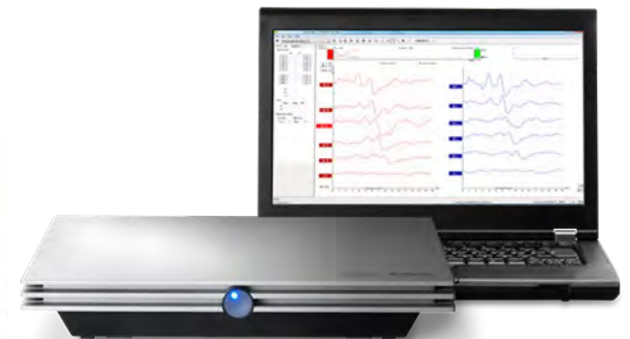
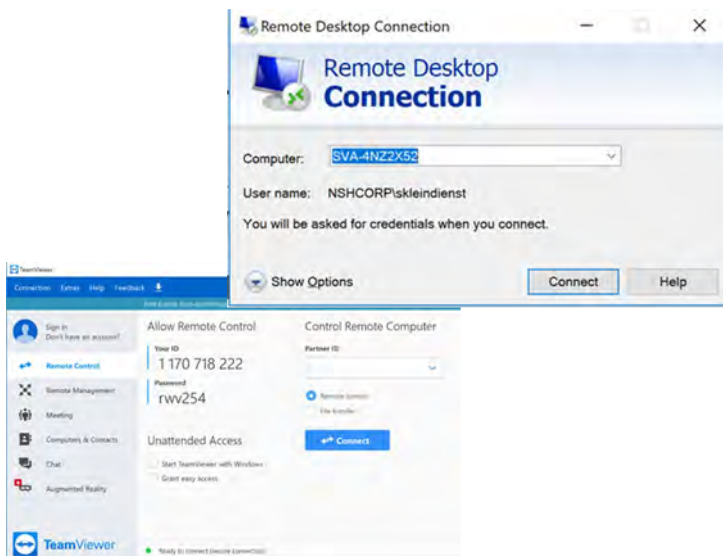
- Qualind™ (good, fair, poor)
 - age, gender, false alarm rate, response time



Margolis et al. 2007

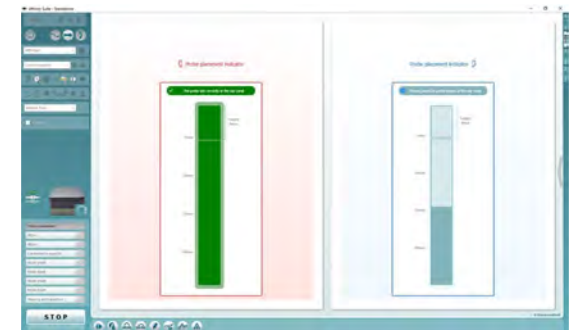
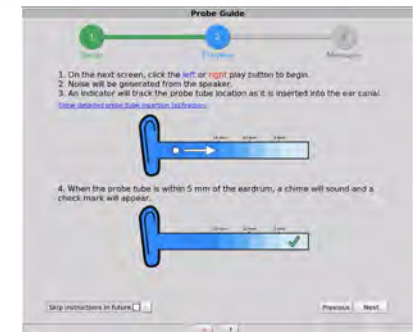
Advanced Testing

- Otoacoustic Emissions
- Auditory Brainstem Response



Rehabilitation

- Amplification
 - Fitting, real-ear measures, programming
 - Self-Fitting
- Aural Rehabilitation
 - LACE
 - Remote therapy session



Rehabilitation

- Adult Hearing Aid Journey

Table 1 Overview of the eHealth services across the phases of the patient journey (N = number of records)

Services	Phases		
	Pre-fitting	Fitting	Post-fitting
(1) Education and information (N = 10)			
(1.1) HL and HA information (N = 3)	✓		✓
(1.2) Counselling and patient education (N = 10)	✓		✓
(1.3) Group discussions and forums (N = 4)	✓		✓
(2) Screening and assessment (N = 4)			
(2.1) Pure-tone audiometry (N = 1)	✓		
(2.2) Speech-audiometry (N = 2)	✓	✓	
(2.3) Self-assessment and PROM/PREM (N = 4)	✓	✓	✓
(3) Hearing rehabilitation (N = 14)			
(3.1) Sound enhancement (N = 2)		✓	
(3.2) HA control and fitting (N = 6)		✓	
(3.3) Auditory and cognitive training (N = 9)	✓		✓
(4) General (tele-audiology) (N = 3)	✓	✓	✓

HA hearing aid, HL hearing loss, PROM patient-reported outcome measures, PREM patient-reported experience measures

Rehabilitation

- Cochlear Implants
 - ECAP thresholds, Speech Perception, Mapping, Aural Rehabilitation
 - Environmental Noise: DAI
 - Impedance measurements from home
 - Self-Fitting



Sevier et al. 2019 (DAI); Parreño et al. 2020 (Impedance); Meeuws et al. 2020

Teleaudiology Examples



Benefits



Extends services and improves access



Improves efficiency, continuity and timely service delivery



Addresses provider shortages



Improves satisfaction



Interdisciplinary Collaboration

Challenges



Standards and guidelines



Licensure, credentialing, and privileging



State regulation



Payment/coding/reimbursement



Training and competencies

Teleaudiology Case Study and Discussion

Example Teleaudiology Consult

AFHCAN
WEB

NSHC NOME

User: Samantha Kleindienst Robler AuD, PhD

[My Settings](#) | [Help](#) | [Log Off](#)

[Search Cases](#)

- Create Case
- Messages (31/36)
 - Inbox (7)
 - On Hold (7)
 - Sent to Me
 - Audiology
 - Sent Cases
 - Created Cases
 - Case History
 - Search Cases
- Patients
- Providers
- Groups
- ★ Favorites
 - Edit Favorites
- Administration
 - All Open Cases (4905)
 - Our Open Cases (5193)
 - > 3 days (5112)
 - > 30 days (4648)
 - Cases On Alert
 - Cases with inactive owners (352)
 - Reports
 - Forms Manager

Patient Cases (8 Cases)
 **SOCKPICK, DOMINICK P (M)**
 List cases by: Case Number
 sort: Creation Date

This case has been Archived

[View Patient Record](#) [Cases \(8\)](#)
 Creator Samantha Kleindienst Robler AuD, PhD (07/02/2019)

Administrative Forms (0) **Case Options**
[Add Comment](#)
[View Activity](#)
[Notify Other User](#)
[All Case Options](#)

Samantha Kleindienst Robler AuD, NSHC NOME
PhD

Comments:

ENT in-person appt 7/31/2019 at 10:15am here in Nome with Steinberg. (07/05/2019 1:52 PM)
 Reached dad and communicated information about drops. Shared appt time and date and stressed importance of keeping appt. (07/05/2019 2:40 PM)

ANMC

Comments:

I have reviewed this case of a 14 year old male with intermittent left sided otorrhea. I have reviewed the attached images as well as the audiogram. I reviewed this chart in Cerner with encounters in 2/19 and 6/19.

Right TM appears intact and in neutral position without fluid in the middle ear space. The left TM is obscured by something - I can't tell if it is pus or squamous debris. I do see that he has a high frequency conductive loss on the left compared to the right. Cholesteatoma is certainly a possibility although difficult to definitively diagnose without a microscope exam. For the short term, I recommend ciproflox drops, 4 drops in the left ear BID x 1 week. This may dry up the ear. Another set of images in 2-3 weeks would be helpful especially if the ear has dried up. I do recommend an in-person evaluation. He should be seen at the next Nome field clinic (doesn't need a new audio). (07/02/2019 5:29 PM)

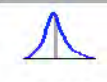
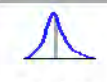
Samantha Kleindienst Robler AuD, NSHC NOME
PhD

Comments:

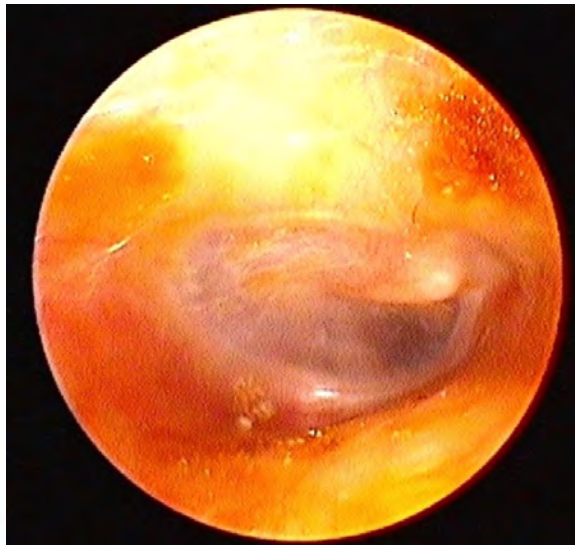
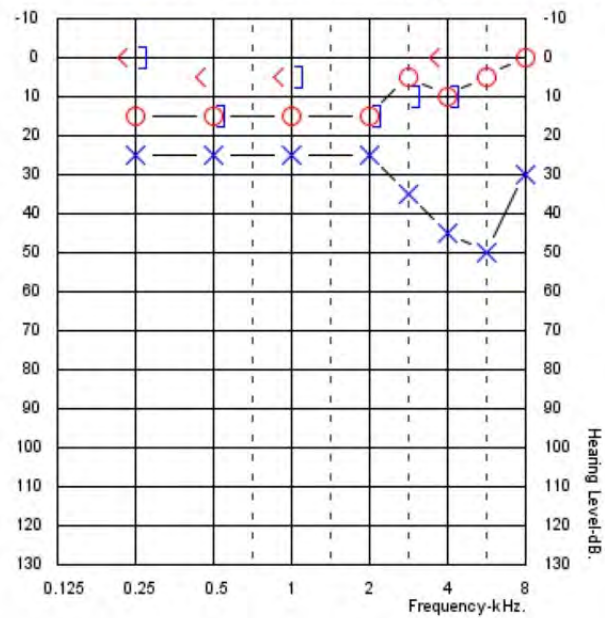
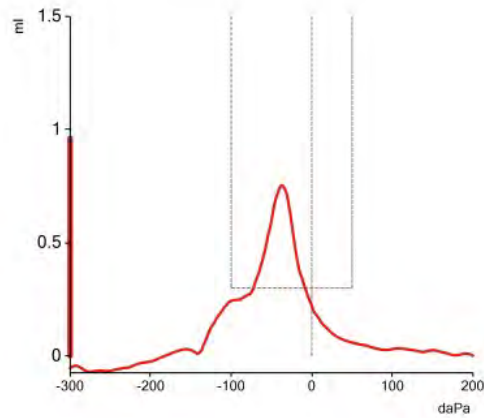
14 y/o male referred from primary care clinic due to unresolved intermittent left otorrhea. On chart review, I see only one audiology encounter for a CHA telemed for cough and fever with slight ETD. No other pertinent history. He has been seen in PCC multiple times. I see 2 encounters in 2017, 2/2019, and then 6/2019. He was treated with Ciprodex and/or Augmentin. He was referred into NSHC ENT field clinic but family did not make appts in March and June 2019. Dad tells me he was not aware appts were scheduled. No audiograms on file. Otalgia denied. He does feel like the right ear hears better than the left. Intermittent tinnitus. Denies vertigo. He is wicking ears successfully daily.

I'm concerned about the left ear. Audio should slight to moderate CHL. I don't think he's been managed for this before and it looks like it's been going on for 2 years. Concerns for cholesteatoma? (07/02/2019 4:59 PM)

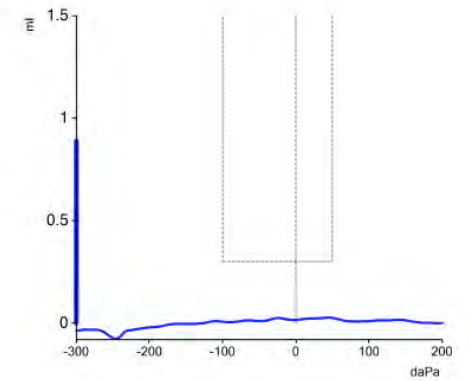
Attachments:

 Right
  Left
  Left
  Left
  Left
  Left
  Impedance Left Ear 07/02/2019,
  Impedance Right Ear 07/02/2019,
  audio 7-02-2019.png

ECV: 0.96 ml
 Peak: 0.75 ml at -38 daPa
 Probe tone: 226 Hz
 Pressure: 200 ... -300 daPa at 200 daPa/s



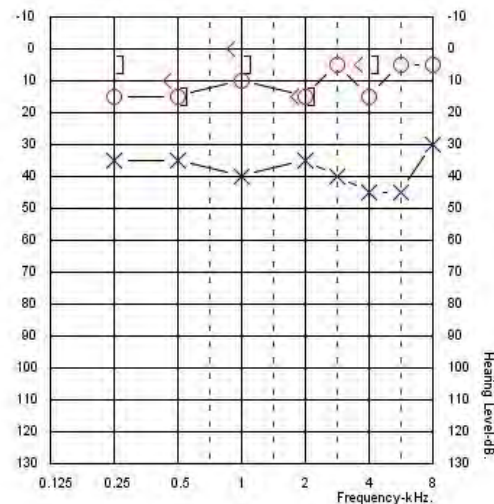
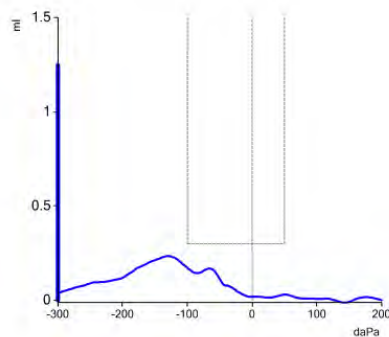
ECV: 0.89 ml
 Peak: ...
 Probe tone: 226 Hz
 Pressure: 200 ... -300 daPa at 200 daPa/s



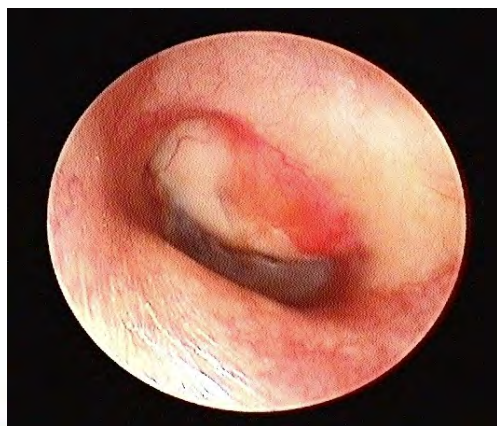
- 10/2019 left t-mastoidectomy



ECV: 1.25 ml
Peak: 0.23 ml at -129 daPa
Probe tone: 226 Hz
Pressure: 200 ... -300 daPa at 200 daPa/s



- 4/2022 left t-mastoidectomy with PORP



	Volume (mL)	Type	Pressure (daPa)	Compliance (mL)
Right	2.4	Ad	-37	1.9
Left	2.7	A	-26	.9 ✓



Other Applications for Teleaudiology

Implementation

Where to Start

Clinical Need

- Screening
- Diagnostics
- Intervention

- Existing Patients
- New Patients

Technology

- Hardware
- Software

- Video
- Peripherals
- Portals
- EHRs
- Communication

Models

- Real time
- Asynchronous
- Hybrid
- E-consult

Personnel

- Facilitator
- Staff resources

- Training
 - Initial
 - On-going

Reimbursement

- Documentation
- Coding/Billing

Teleaudiology Implementation

- Assess and Define Clinical Need
 - Includes market analysis
- Develop and Plan
 - Who, what, when, where, how
- Build a Team and provide training
- Implement, evaluate, and monitor

Teleaudiology Implementation Example

An example of how to evaluate existing software and hardware technology currently in use for teleaudiology service delivery





Chapter 2: Set-up and Implementation of Teleaudiology Practice

Chapter Authors: Samantha Kleindienst Robler, Laura Coco, Bopanna Ballachanda, Mark Krumm

Book Title: Teleaudiology for Clinicians

Editors: Eldre Beukes, Vinaya Manchaiah, and De Wet Swanepoel

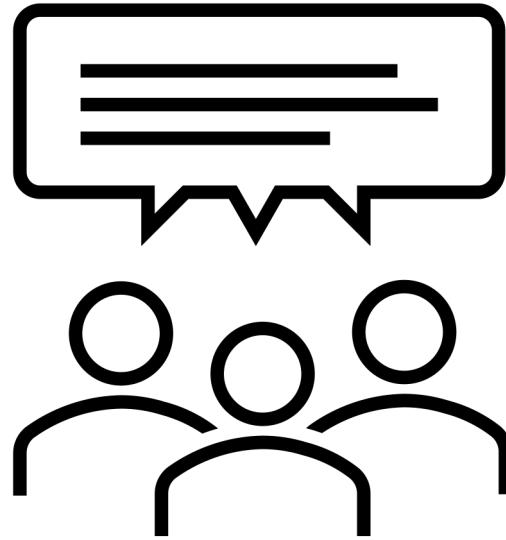
Summary and Key Take Aways



- Equity
- patient satisfaction
- provider shortage
- efficiency and continuity

- Technology/infrastructure
- Training, guidelines, competences

- Licensure
- Reimbursement



Q&A

References

- Barbour DL, Howard RT, Song XD, Metzger N, Sukesan KA, DiLorenzo JC, Snyder BRD, Chen JY, Degen EA, Buchbinder JM, Heisey KL. Online Machine Learning Audiometry. *Ear Hear*. 2019 Jul/Aug;40(4):918-926. doi: 10.1097/AUD.0000000000000669. PMID: 30358656; PMCID: PMC6476703.
- Bennett, R. J., Eikelboom, R., Swanepoel, D. W., & Manchaiah, V. (2020). Tele-audiology services in Australia: A shift in clinical practices. *Audiol. Now*, 81, 11-13.
- Bennett, R. J., Kelsall-Foreman, I., Barr, C., Campbell, E., Coles, T., Paton, M., and Vitkovic, J. (2022). "Barriers and facilitators to tele-audiology service delivery in Australia during the COVID-19 pandemic: perspectives of hearing healthcare clinicians," *International Journal of Audiology*, 1-10.
- Chan, J., Najafi, A., Baker, M., Kinsman, J., Mancl, L. R., Norton, S., Bly, R., and Gollakota, S. (2022). "Performing tympanometry using smartphones," *Communications Medicine* 2, 57.
- Chan, J., Raju, S., Nandakumar, R., Bly, R., and Gollakota, S. (2019). "Detecting middle ear fluid using smartphones," *Science Translational Medicine* 11, eaav1102.
- De Sousa KC, Manchaiah V, Moore DR, Graham MA, Swanepoel DW. Effectiveness of an Over-the-Counter Self-fitting Hearing Aid Compared With an Audiologist-Fitted Hearing Aid: A Randomized Clinical Trial. *JAMA Otolaryngol Head Neck Surg*. 2023;149(6):522–530. doi:10.1001/jamaoto.2023.0376
- D'Onofrio, K. L., and Zeng, F.-G. (2022). "Tele-Audiology: Current State and Future Directions," *Frontiers in Digital Health* 3.
- Eikelboom, R. H., Swanepoel, deW., Motakef, S., & Upson, G. S. (2013). Clinical validation of the AMTAS automated audiometer. *International journal of audiology*, 52(5), 342–349.
<https://doi.org/10.3109/14992027.2013.769065>

References

- Ferrari DV, Bernardez-Braga GRA. Remote probe microphone measurement to verify hearing aid performance. *Journal of Telemedicine and Telecare*. 2009;15(3):122-124. doi:10.1258/jtt.2009.003005
- Mahomed, F., Swanepoel, deW., Eikelboom, R. H., & Soer, M. (2013). Validity of automated threshold audiometry: a systematic review and meta-analysis. *Ear and hearing*, 34(6), 745–752. <https://doi.org/10.1097/01.aud.0000436255.53747.a4>
- Margolis, R. H., Saly, G. L., Le, C., & Laurence, J. (2007). Qualind: A method for assessing the accuracy of automated tests. *Journal of the American Academy of Audiology*, 18(1), 78–89. <https://doi.org/10.3766/jaaa.18.1.7>
- Meeuws, M., Pascoal, D., Janssens de Varebeke, S., De Ceulaer, G., & Govaerts, P. J. (2020). Cochlear implant telemedicine: Remote fitting based on psychoacoustic self-tests and artificial intelligence. *Cochlear implants international*, 21(5), 260–268. <https://doi.org/10.1080/14670100.2020.1757840>
- Paglialonga, A., Cleveland Nielsen, A., Ingo, E., Barr, C., & Laplante-Lévesque, A. (2018). eHealth and the hearing aid adult patient journey: a state-of-the-art review. *Biomedical engineering online*, 17(1), 101. <https://doi.org/10.1186/s12938-018-0531-3>
- Parmar, B., Beukes, E., & Rajasingam, S. (2022). The impact of COVID-19 on provision of UK audiology services & on attitudes towards delivery of telehealth services. *International journal of audiology*, 61(3), 228–238. <https://doi.org/10.1080/14992027.2021.1921292>
- Parreño, M., Di Lella, F. A., Fernandez, F., Boccio, C. M., and Ausili, S. A. (2020). "Toward Self-Measures in Cochlear Implants: Daily and "Homemade" Impedance Assessment," *Frontiers in Digital Health* 2.
- Robler, S. K., Coco, L., and Krumm, M. (2022). "Telehealth solutions for assessing auditory outcomes related to noise and ototoxic exposures in clinic and research," *The Journal of the Acoustical Society of America* 152, 1737-1754.
- Sevier, J. D., Choi, S., & Hughes, M. L. (2019). Use of Direct-Connect for Remote Speech-Perception Testing in Cochlear Implants. *Ear and hearing*, 40(5), 1162–1173. <https://doi.org/10.1097/AUD.0000000000000693>
- Sweetow, R. W., & Sabes, J. H. (2006). The need for and development of an adaptive listening and communication enhancement (LACE™) program. *Journal of the American Academy of Audiology*, 17(08), 538-558.

Acknowledgements

- The presenters would like to thank Dr. Laura Coco for her work in co-creating the teleaudiology video demonstrations with Dr. Robler



Contact Us!

Samantha Kleindienst Robler, AuD, PhD

- skrobler@uams.edu
- skleindienst@nshcorp.org



Aaron Roman, AuD

- aroman2@salus.edu

