

# Video-Otoscopy in Telehealth

Leigh Biagio<sup>1</sup>, Prof De Wet Swanepoel<sup>1-3</sup>, Prof Claude Laurent<sup>1,4</sup>,  
Prof James. W. Hall III<sup>1</sup>, Dr Adebolajo Adeyemo<sup>5-6</sup>, Dr T.  
Lundberg<sup>4</sup>, Prof Bart Vinck<sup>1</sup>

1. Department of Communication Pathology, University of Pretoria, South Africa

2. Ear Sciences Centre, School of Surgery, the University of Western Australia, Nedlands, Australia

3. Ear Science Institute Australia, Subiaco, Australia

4. Umeå University, Sweden

5. Institute of Child Health, University of Ibadan, Ibadan, Nigeria.

6. Ear, Nose and Throat Department, University College Hospital, Ibadan, Nigeria.



## introduction



- The global revolution in connectivity & advances in technology = hearing health delivery through telehealth is becoming increasingly possible to underserved regions.
- Previous: video-otoscopic images are equivalent in quality to face-to-face otoscopy; & average to good diagnostic concordance
- No validation studies on video-otoscopic images taken by a telehealth clinic facilitator without formal tertiary education, in a heterogeneous underserved community.



## underserved area



## primary health care clinic



## Witkoppen patients



- Witkoppen Health and Welfare Centre serves as a specialist centre for HIV and TB treatment
- In 2012 the clinic had 95,521 patient visits
- 25% of the adults tested in 2012 were HIV positive
- 4.0% of the paediatric population (14 years and younger) tested positive for HIV in 2012



## conductive pathology



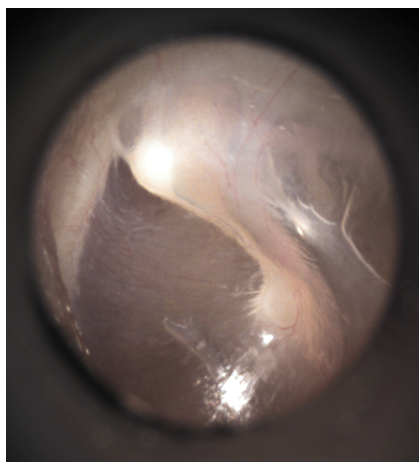
- Early diagnosis of middle ear pathology is important as OME responsible for a significant burden of disease in developing countries
- Medical complications from untreated middle ear pathology
- Children with low CD4 counts = nearly 3 x increased risk of recurrent AOM
- A within-subject comparative research design. Sample of 61 adult subjects recruited from patients of the primary health care clinic



## methodology



## example

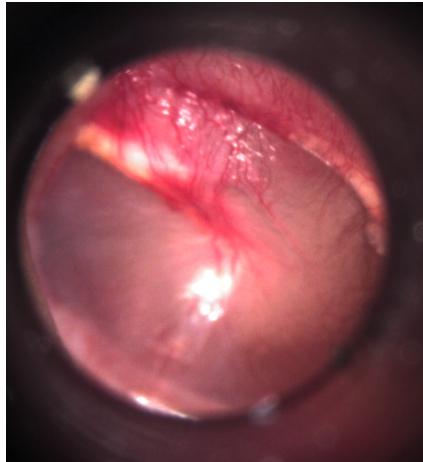


Normal tympanic  
membrane





## example

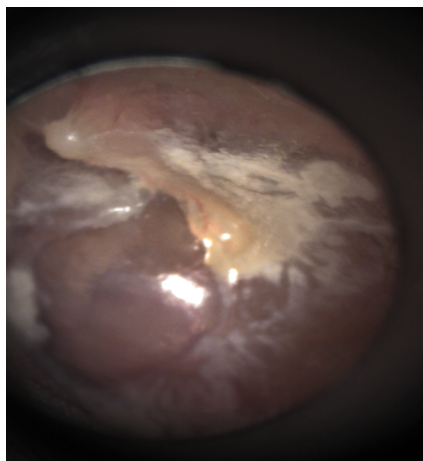


Inflamed over pars flaccida  
and over handle of malleus

Acute otitis media



## example



Central perforation with  
otomycosis



## video-otoscopy image grading

**Table 1. Video-otoscopic image grading for images acquired by the otolaryngologist and facilitator (n = 240)**

Image grading	Otolaryngologist images %	Facilitator images %
0 Unacceptable	15.0	23.4
1 Acceptable	24.2	29.2
2 Excellent	60.8	47.4

=  
85%

= 76.6%



## concordance

**Table 2 Comparison of asynchronous assessment of video-otoscopic images acquired by the otolaryngologist and facilitator (n = 240 ears).**

	Assessability of asynchronous video- otoscopy images (%)		Concordance* between asynchronous video-otoscopy images	
	Otolaryngologist images:	Facilitator images:	Kappa value	Asymp. std. error
TM Surface structure	81.1	71.3	0.693	0.068
TM Texture	81.1	72.1	0.574	0.076
TM Colour	82.8	73.0	0.512	0.071
TM Position	77.9	68.9	0.484	0.067
Diagnosis	-	-	0.483	0.070

\*Concordance between asynchronous assessment of images acquired by the otolaryngologist and facilitator.



## sensitivity and specificity

**Table 4. Sensitivity, specificity and diagnostic odds ratios for asynchronous video-otoscopy using images acquired by an otolaryngologist and facilitator (n = 240).**

Face-to-face otoscopy	Unable to diagnose	Sensitivity		Specificity		Diagnostic odds ratio	
			(95% CI)		(95% CI)		(95% CI)
Otolaryngologist images	5	0.80	(0.61 to 0.91)	0.91	(0.83 to 0.95)	41.00	(12.11 to 138.82)
Facilitator images	12	0.85	(0.68 to 0.94)	0.89	(0.80 to 0.94)	46.00	(12.95 to 163.46)



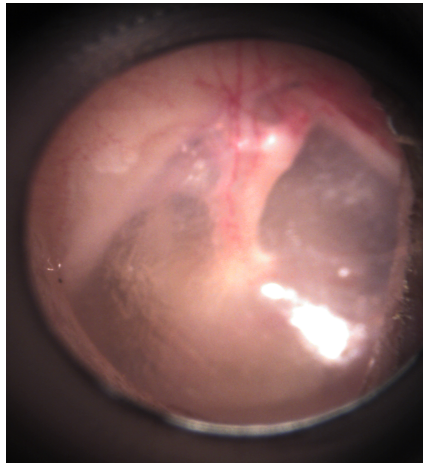
## diagnoses

**Table 5 Otologic diagnoses made using face-to-face otoscopy and asynchronous otoscopy using video-otoscopic images acquired by an otolaryngologist and facilitator (n = 240 ears)**

	Otoscopy %	Otolaryngologist images %	Facilitator images %
Normal	53.3	68.0	57.4
Retracted tympanic membrane	21.3	3.3	4.9
Wax in canal	12.3	10.7	14.8
Chronic suppurative otitis media	5.7	4.9	4.1
Otitis media with effusion	3.3	4.1	4.9
No image / otoscopy not performed	1.6	1.6	1.6
Exostosis	0.8	1.6	0.8
Foreign body in canal	0.8	0.8	0.8
Otomycosis	0.8	0.8	0.8
Image not reliable to make diagnosis	N/A	4.1	9.8



## example

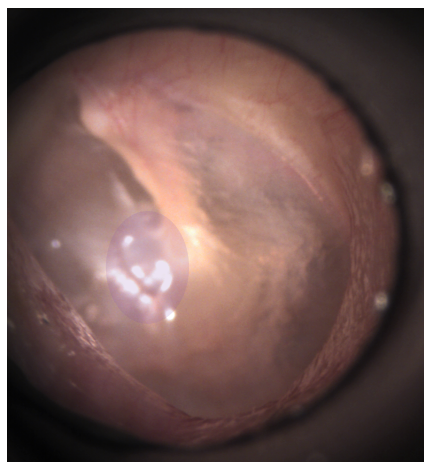


Video-otoscopy: normal

Face-to-face otoscopy:  
retracted



## example



Video-otoscopy: normal

Face-to-face otoscopy:  
perforation



## Study limitations & recommendations for further research



- Still images don't provide depth perception
- Video-otoscopic recordings may possibly improve depth perception and view of the TM attic
- Participants were adults
- Otitis media is more prevalent in paediatric population
- The need for expert diagnosis is likely to be greater for paediatric population
- Otomicroscopy considered true standard



## Paediatric otitis media at a primary health care clinic



- A sample of 140 children aged 2 to 16 years (average age = 6 years 5 months; 62 female)
- Recruited from paediatric patients attending Witkoppen clinic for any reason
- Otomicroscopy was completed for each ear of participants by a specialist otologist using a Leica M525 F40 surgical microscope
- 4 participants did not co-operate
- Otomicroscopy completed for 136 participants (272 ears)





## Video-otoscopic recordings in children within a telehealth service



## Wax removal and residual obstruction of the TM

	2 to 5 yrs <i>n=76 (152 ears)</i>	6 to 15 yrs <i>n=60 (120 ears)</i>	Total <i>n=136 (272 ears)</i>
<b>Cleaned</b>	39.5 (23.7)	31.7 (23.3)	36.0 (23.5)
<b>No obstruction</b>	30.3 (38.2)	46.7 (55.8)	37.5 (46.0)
<b>Partial obstruction</b>	67.1 (55.9)	45.0 (34.2)	57.4 (46.3)
<b>Complete obstruction</b>	13.2 (5.9)	18.3 (10.0)	15.4 (7.7)



## Prevalence of otitis media

	All <i>n</i> =136 (272 ears)	2 to 5 yrs <i>n</i> =76 (152 ears)	6 to 15 yrs <i>n</i> =60 (120 ears)	Male <i>n</i> =74 (148 ears)	Female <i>n</i> =62 (124 ears)	Left <i>n</i> =136	Right <i>n</i> =136
	% of subjects (% of ears)						
<b>Otitis media:</b>	22.1 (16.5)	27.7 (21.0)	15.0 (10.9)	25.7 (19.6)	17.7 (11.7)	17.7	15.4
<b>AOM</b>	1.5 (0.7)	2.6 (1.3)	0.0 (0.0)	1.4 (0.7)	1.6 (0.8)	1.5	0.0
<b>CSOM</b>	5.9 (4.8)	4.0 (3.3)	8.3 (6.7)	6.8 (5.4)	4.8 (4.2)	4.4	5.1
<b>SOM</b>	14.7 (11.0)	21.1 (16.4)	6.7 (4.2)	17.6 (13.5)	11.3 (6.7)	11.8	10.3
<b>Undetermined</b>	13.2 (7.7)	13.2 (7.9)	13.3 (7.5)	14.9 (8.8)	11.3 (6.7)	6.6	8.8
<b>Normal</b>	66.9 (75.7)	60.5 (71.1)	75.0 (81.7)	62.2 (71.6)	72.6 (81.7)	75.7	75.7



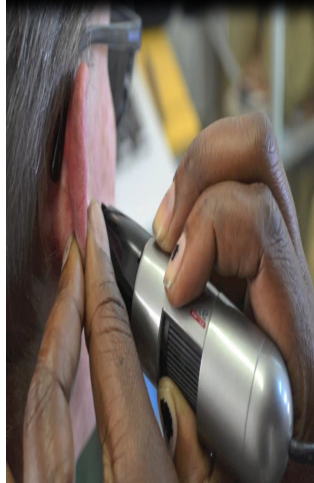
## Paediatric otitis media at a primary health care clinic



- The prevalence for CSOM places South Africa among the high prevalence group
- Compared to large study on school children in India with similar socio-economic conditions, CSOM and SOM prevalence is higher in current study
- Compared to global estimations of 10.85%, the AOM prevalence was surprisingly low, especially in a paediatric population considered at high risk for otitis media
- SOM prevalence higher compared to previous studies with paed with H



## Video-otoscopic recordings in children within a South African telehealth service



- A within-subject comparative design was employed with an unselected sample of 140 children
- Otomicroscopy = gold standard
- Dino-Lite video-otoscope
- Video-otoscopic recordings of 30 seconds were recorded by the facilitator from each ear.
- Recordings and patient info randomised and uploaded to server
- 4 & 8 weeks later, otologist and GP accessed the server from Sweden, independently rated and made a decision from each recording



## Video-otoscopic recordings in children within a telehealth service



- 75.3% recordings = acceptable / excellent
- More recordings graded as excellent in 2<sup>nd</sup> week of data collection, indicating learning curve

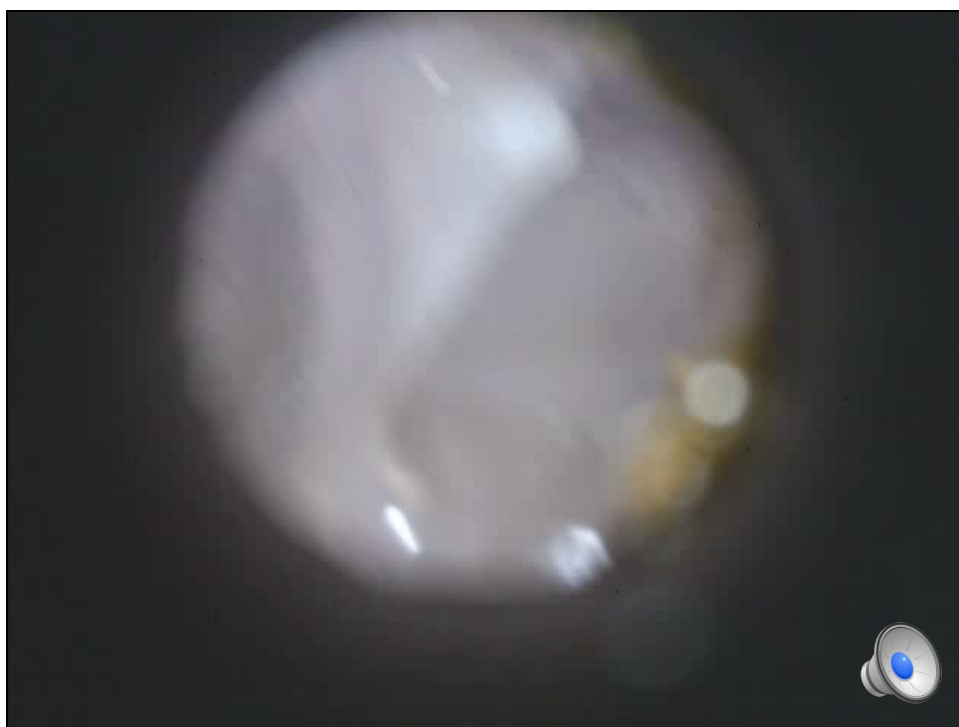


## examples



Video-otoscopic recordings:

- Normal

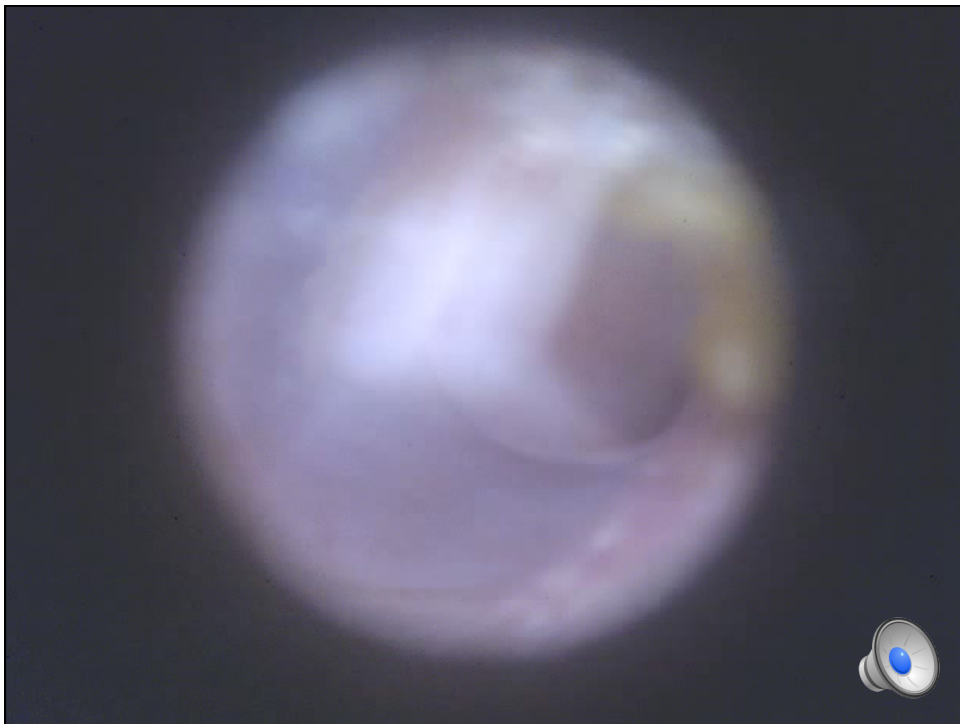


## examples



Video-otoscopic recordings:

- Large central perforation
- Severe retraction of TM



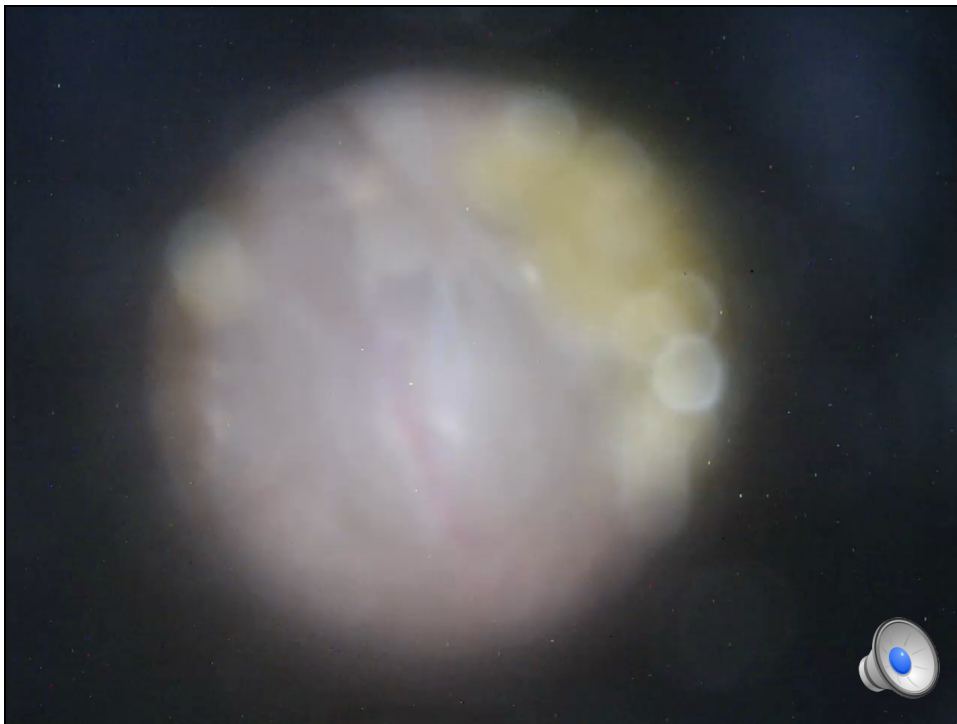


## examples



Video-otoscopic recordings:

- Severe retraction of TM





## Inter- and intra-rater concordance

		Concordance* between asynchronous video-otoscopic recordings (n= 272)	
		Kappa value	Asymp. std. error
Inter-rater diagnosis	Week 4	0.926	0.011
	Week 8	0.930	0.011
Intra-rater diagnosis	Otologist	0.938	0.011
	General Practitioner	0.928	0.011



## Otomicroscopy / video-otoscopic recording concordance

		Concordance* between asynchronous video-otoscopy recordings (n=272)	
		Kappa value	Asymp. std. error
Week 4	Otologist	0.851	0.015
	General Practitioner	0.842	0.015
Week 8	Otologist	0.873	0.014
	General Practitioner	0.854	0.015



## Sensitivity and specificity

Face-to-face otomicroscopy		Sensitivity		Specificity		Diagnostic odds ratio	
		(95% CI)		(95% CI)		(95% CI)	
Otologist	Week 4	0.83	(0.68 to 0.92)	0.91	(0.86 to 0.95)	50.33	(18.07 to 140.23)
	Week 8	0.82	(0.67 to 0.91)	0.95	(0.91 to 0.98)	88.57	(29.93 to 262.08)
	Total	0.82	(0.72 to 0.89)	0.93	(0.90 to 0.95)	63.45	(30.47 to 132.11)
General practitioner	Week 4	0.77	(0.62 to 0.87)	0.94	(0.89 to 0.97)	54.44	(19.95 to 148.58)
	Week 8	0.78	(0.63 to 0.89)	0.97	(0.93 to 0.99)	112.38	(34.34 to 367.78)
	Total	0.78	(0.67 to 0.86)	0.96	(0.93 to 0.97)	74.87	(35.00 to 160.15)



## conclusion



A hearing telehealth facilitator, with little or no previous experience in health care, can, through acquisition of video-otoscopic recordings, provide a means for asynchronous diagnosis of otologic pathology in a primary health care setting in underserved areas.



## conclusion



Video-otoscopy may have a significant role to play in the early detection of middle ear disease and in the prevention or timely management of life-threatening pathology in developing countries.



where will telehealth lead us?  
who nose...



## acknowledgements

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UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

Correspondence: leighbiagio@gmail.com

