

The use of Otoacoustic Emissions in Noise Induced Hearing Loss prevention

Mine Medical Practitioners Association Conference
Valley Lodge Magaliesberg

9 October 2010

Acknowledgments

Angloplatinum

Mogalakwena mine management

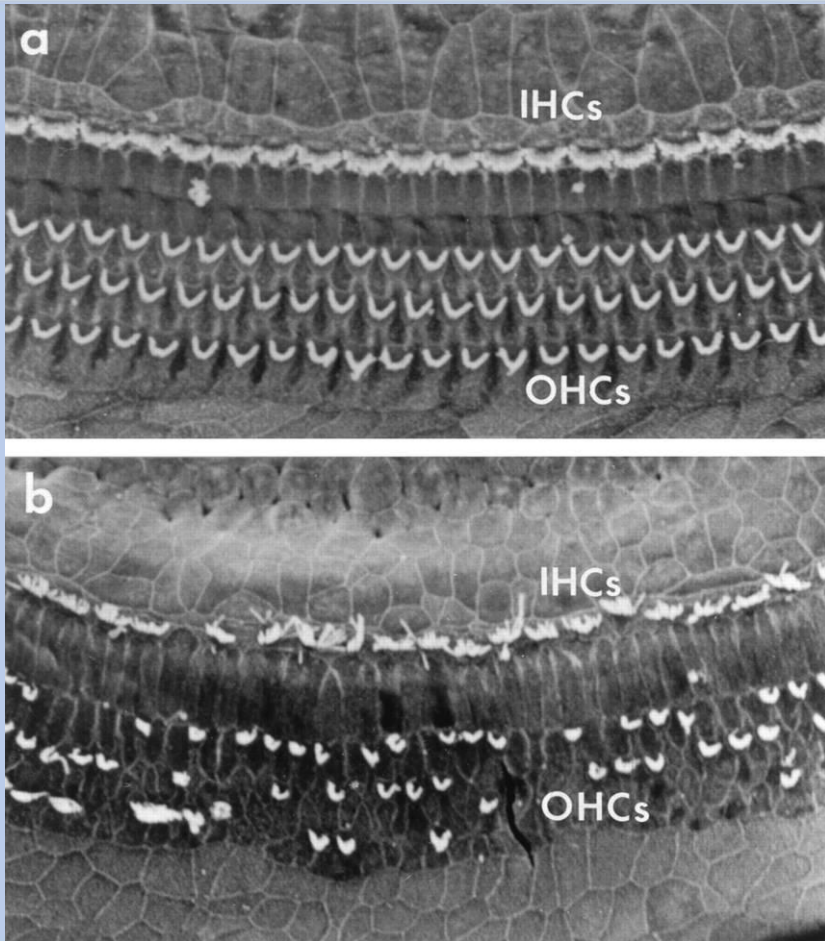
Dr. Cas Badenhorst

Mr. Pieter van Coller

Mrs. Leonie van Coller

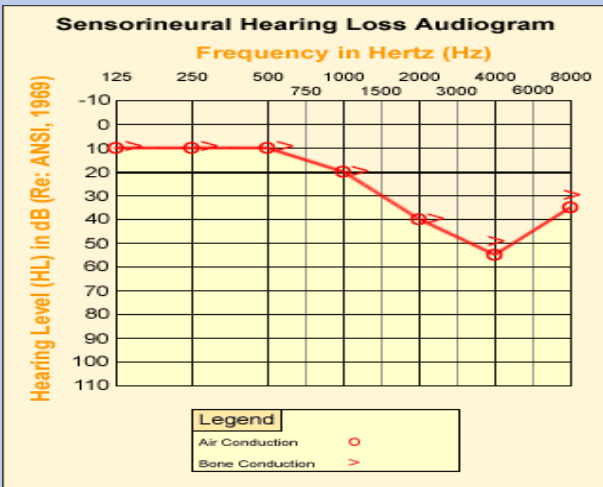
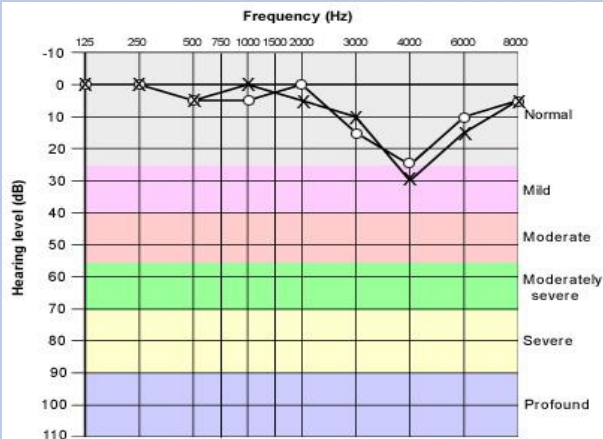
Volunteers

Outline of presentation



- Introduction
- Otoacoustic Emissions
- Methodology
- Results
- Conclusion
- Recommendations

Introduction



NIHL continues to result in reduced worker quality of life + compensation costs

NIHL is a permanent condition – if we are to prevent it we need an approach that will allow early identification of the development of NIHL

The audiogram is a subjective method that relies on co-operation from the worker

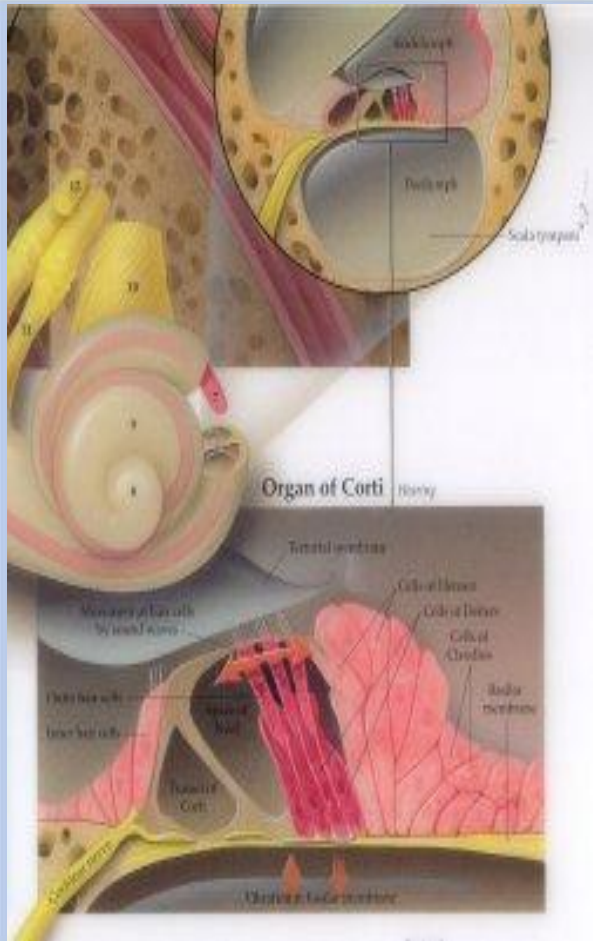
Alternative or adjunct approach is an objective testing method

Otoacoustic Emissions

Copy of dancing hair cell.wm

- Otoacoustic Emissions (OAEs) are a feasible alternative
- Large body of research in laboratory- main clinical use on identification of hearing loss in newborn babies
 - Clinically sensitive tool for assessing NIHL and the outer hair cells (OHC)
 - repeatable results
 - identify cochlear damage before evidenced on an audiogram – normal audiogram but evidence of OHC loss
 - Feasible method of evaluating HPD effectiveness using temporary emission shift (TES)
 - CSIR research developed a prediction model for Hearing Threshold Levels

Otoacoustic Emissions

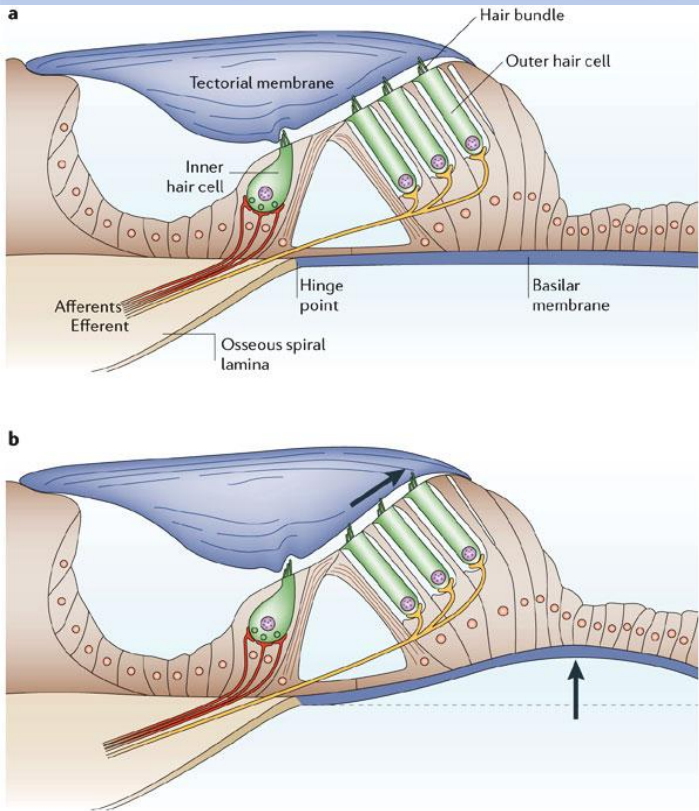


Three types of OAEs: Spontaneous (SOAE), Transient (TEOAE), Distortion Product (DPOAE)

DPOAE measurement

- Probe in the outer ear
- Probe houses the measuring microphone and sound emitting transmitter
- Sound transmitter presents two moderate level tones in pairs (f_1 and f_2) over a range from low to high frequency
- The sounds enter the outer, middle, and inner ear
- Very small sound waves emitted back through the middle ear from the interaction of the two tones in the fluid of the cochlea
- Recording microphones pick up the small sounds coming back from the inner ear
- The computer averages and processes the responses

Otoacoustic Emissions



Copyright © 2006 Nature Publishing Group
Nature Reviews | Neuroscience

Reliable OAE test results require:

- Normal middle ear functioning- need tympanogram
- Relatively quiet room- there should be a 10dB difference between the emission level and the noise floor (SNR)
- Hearing threshold levels impact on results- must use DPOAEs and diagnostic test protocol

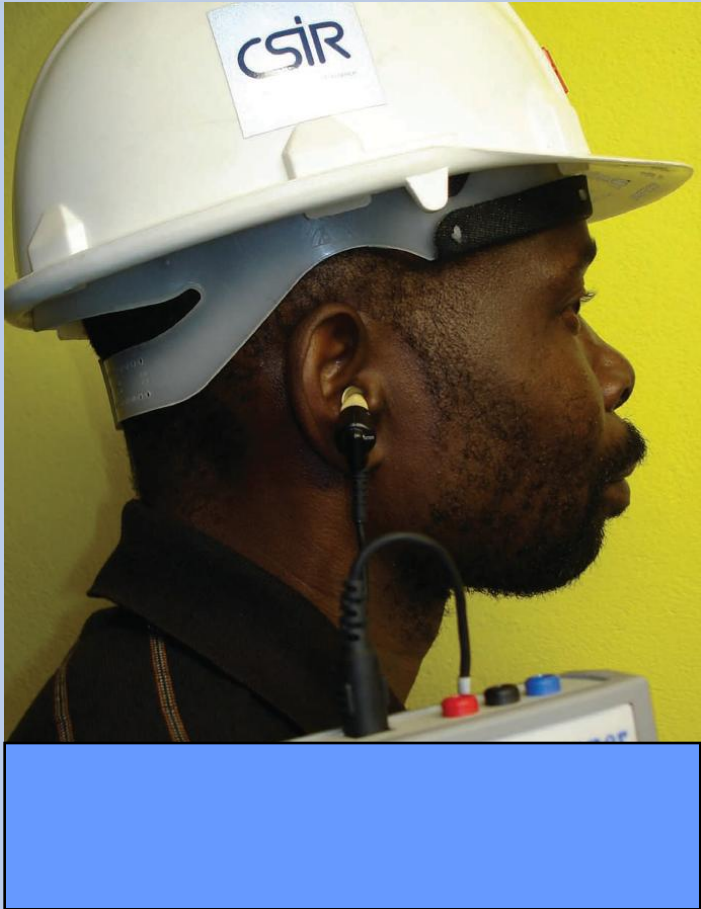
Methodology



Objectives

- To evaluate the **signal-to-noise ratio** of the DPOAE test results when the tests were conducted in **different venues** in an Occupational Health Centre by a **technician**;
- To evaluate the viability of DPOAE testing in a population that has been exposed to noise and therefore may have **existing hearing loss**;
- To evaluate the ability of DPOAE test results to identify **early NIHL**.

Methodology



Sample

56 platinum mine employees

Annual medical

Two venues- same tester

- on the mine premises where HPDs were being checked
 - Noisy road outside where trucks passed by periodically
- at a town clinic where contractors were tested
 - Quiet back room shared with x-ray technician

Only male subjects

Years of service-generally low

37 worked for 3 years or less

Methodology

Age category	n
20-30 yrs	36
31-40 yrs	35
41-50 yrs	18
51-60 yrs	8
>60 yrs	3
Total	100

Procedure

Approved by the Research Ethics Committee

Each ear a separate record - 100 ears

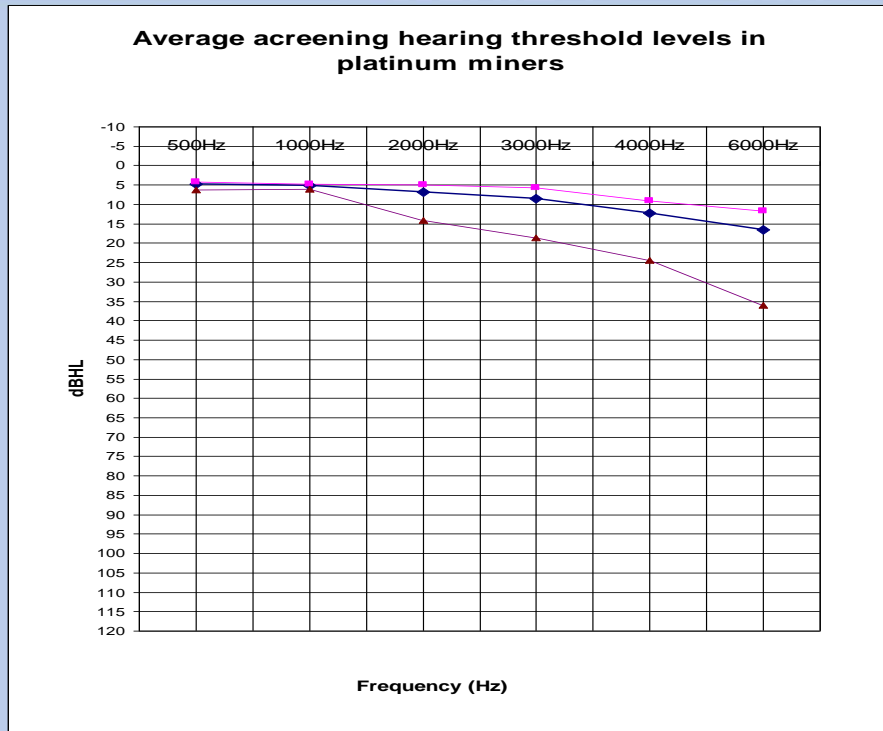
Conducted an otoscopic examination

Conducted a tympanogram to ensure normal middle ear function

Test conducted by a technician who had approximately two days of training

Downloaded the results and evaluated and interpreted by an audiologist

Methodology



Mine-Interacoustics automated AS216 audiometer and the results were recorded using the Everest Audio program version 2.04.

Town clinic-Tremetrics RA650 automatic audiometer that was automatically recorded with the African Management Software Program

The hearing levels in this sample were on average within normal limits 20% of subjects presented with mild-to-moderate HTLs at certain test frequencies

Results

Signal-to-noise ratio (SNR)

f_2 Frequency	633Hz	797Hz	996Hz	1266Hz	1605Hz	2027Hz	2555Hz	3234Hz	4055Hz	5133Hz	6434Hz
Clinic	8.9	11.3	13.3	14.6	15.6	14.6	12.6	13.7	19.9	15.2	7.9
Mine	10.0	12.8	13.4	15.9	15.2	14.9	12.5	14.2	20.3	17.1	6.4

Most SNR >10dB indicates sufficient ambient noise control for reliable test results in a medical surveillance situation

Results

Indication of early NIHL

Early identification = audiogram thresholds are within normal limits but emission levels are lower than the Vanderbijlt norms expected range of normal DPOAE levels indicated on the GSI

Hearing Level	Number of ears	Early Identification Reduced OAE for audiogram result	Expected OAE for audiogram result
Normal hearing	73	53	20

Conclusions

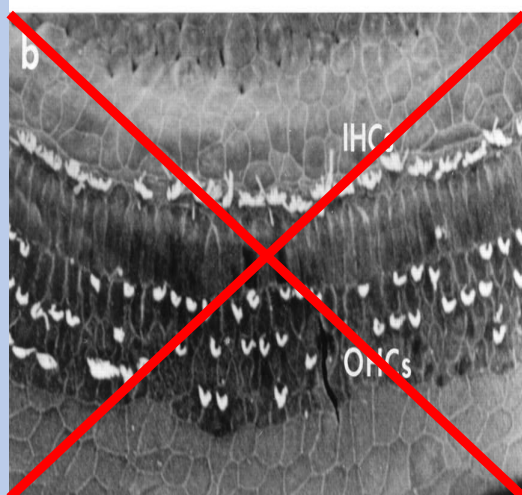
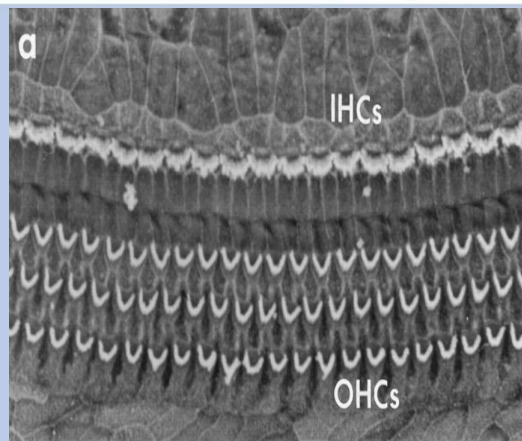


The study provides evidence that

DPOAE is a **feasible test** in an occupational health centre environment as ambient noise can be sufficiently controlled

A trained technician can obtain **reliable** DPOAE results in an occupational health centre
DPOAE testing appears to be a feasible tool for early indication of NIHL in the mining industry if used to counsel workers

Recommendations



More knowledge needed:

Hearing threshold levels of miners- will DPOAE work on all NIHL populations? Years of service low and relatively normal hearing levels

Download abilities of the current equipment is not user friendly

Need a middle ear function check- tympanograms and reflex testing – good requirement then barotrauma will be fully evaluated and prevalence better understood

Early identification analysis required skilled person or improved automation

Norms for this population need to be established

Thank You