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Remote evaluation of video-otoscopy recordings in an unselected pediatric population with an otitis media scale

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ABSTRACT

Background: A recently validated image-based grading scale for acute otitis media (OMGRADE) can be used to assess tympanic membrane (TM) status. The aim of this study was to evaluate the validity and reliability of this scale for remote assessments of TM status using video-otoscopy recordings in an unselected pediatric population.

Method: Children 2–16 years attending a South African primary health clinic were offered an ear examination by an otologist using otomicroscopy. An ear and hearing telehealth facilitator then made video-otoscopy recordings (9–33 s) of the ears and uptakes were uploaded to a secure server for remote assessments in Sweden by an otologist and general practitioner at four- and eight-weeks post onsite assessment. TM appearance was judged according to the OMGRADE scale. Concordance between onsite otomicroscopy and asynchronous assessments of video-otoscopy recordings was calculated together with intra- and inter-rater agreements.

Results: One hundred and eighty ears were included. Concordance of TM classifications using the OMGRADE scale was found to be substantial (weighted kappa range 0.66–0.79). Intra- and inter-rater agreement (test–retest) was found to be substantial to almost perfect (weighted kappa range 0.85–0.88 and 0.69–0.72, respectively).

Conclusion: The OMGRADE scale can be used to accurately assess the normal TM and secretory otitis media (SOM) remotely using video-otoscopy recordings in an unselected pediatric population.

1. Introduction

Middle ear infection – otitis media – is among the most common infections in children [1]. The burden of otitis media differs between developed and developing countries with the incidence of acute otitis media (AOM) in sub-Saharan Africa, South Asia and Oceania reported to be two to eight times higher than in other regions of the world [1]. In addition, the lack of sufficient numbers of specialists, such as otolaryngologists, family physicians and audiologists, to serve the majority of populations around the world [2] necessitate new approaches to overcome these discrepancies. In this context telemedicine may be able to offer remote, highly specialized clinical assessments to such underserved areas [3].

Otitis media is a group of different diagnoses including otitis media with effusion (OME), acute otitis media (AOM) and chronic suppurative otitis media (CSOM). To diagnose the various forms of otitis media and their respective stages require an assessment of the tympanic membrane (TM) using either otoscopy, otomicroscopy or, more recently, video-otoscopy with still images or recordings [4]. It is also necessary to use a standardized grading system for the TM appearance in order to classify and grade the disease and its different stages [5,6]. Using a standardized grading scale for otitis media may allow for more comparable assessments of the TM and otitis media diagnoses with less clinical variability.

Different scoring systems and a single AOM grading scale have previously been presented [7–11]. However, in our opinion, the aforementioned systems tend to overestimate the value of the

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Table 1
Different ratings of tympanic membrane status at all assessments.

Label		Description
OMGRADE	Sub-division	
0	0	Transparent TM, normal position
1	1R	Transparent TM, slightly retracted
	1F	Transparent TM, normal position, fluid level or fluid filled ME
	1RF	Transparent TM, retracted with fluid level or fluid filled ME
2	2OF	Transparent TM with opaque fluid level, w/wo retraction
3	3	Opaque appearance of TM in a fairly normal position
4	4	Opaque appearance of TM and bulging
5	5B	Opaque appearance of TM with bullous formations
	5C	Contourless TM with a wet appearance and swollen keratin patches, w/wo pulsating pus from small perforation
Temporary subgrade		
6	6	TM perforation, retraction pocket or cholesteatoma w/wo purulent discharge, previous ear surgery and TM grommets
Not possible to determine		
NPD		Not possible to determine due to obscuring objects, low image quality or inability to inspect the entire TM-surface

Abbreviations: ME: middle ear; w/wo: with or without; NPD: not possible to determine; VO: video-otoscopy.

parameter "redness of the TM" despite colour having been found to be of limited value in diagnosing AOM [11,12]. In order to improve the grading of AOM and to follow the course of the disease over time, a validated image-based grading scale for AOM (OMGRADE scale) was recently developed [13]. It includes different stages seen during the course of AOM, from the normal TM to the pathological TM's in various stages of AOM (Table 1). However, the present OMGRADE scale does not include ears with CSOM.

The OMGRADE scale should be applicable to many clinical situations including telemedicine contexts where a standardized grading system for otitis media can serve as a diagnostic guide for evaluating still TM images or video recordings of TM's remotely, together with evaluation of middle ear effusion by tympanometry or pneumatic video-otoscopy. A study conducted in rural Australia indicated that good quality endoscopic still images of the TM were sufficient for adequate clinical otological diagnosis [14]. Video-otoscopy, utilizing still images, has been shown to have a high sensitivity and specificity as compared to pneumatic otoscopy and tympanometry in evaluating OME [15]. Combining TM images or video recordings of TM's with new systems for hearing assessments in a telemedicine setting could provide a valuable diagnostic tool for rural and underserved areas in the world [4,16].

A recent study has demonstrated that a general ear and hearing telehealth facilitator (EHTF) can be trained to acquire video-otoscopic images for remote diagnosis by professionals (otolaryngologists and general practitioners) from different parts of the world [17].

The aim of this study was to evaluate the validity and reliability of the OMGRADE scale for remote assessment of TM-status using video-otoscopy recordings (video clips) in an unselected pediatric population.

2. Method

2.1. Study population

This consecutive study was conducted following approval from the Institutional Ethics Committee at the University of Pretoria, Pretoria, South Africa.

A sample of 140 children aged 2 to 16 years (range 2–15.8 years, mean age 6.4 ± 3.5 years, 44.4% females) were recruited during a two week period from the entire pediatric population attending a primary health care clinic, irrespective of reason for attendance. The Witkoppen Health and Welfare Centre provides health care services to poor populations, including the Diepsloot community north of Johannesburg. Diepsloot is a densely populated settlement made up of government subsided brick houses and shacks. Unemployment exceeds 90%, and the access to basic services such as running water, sewage and rubbish removal is limited [18]. After verbal and written information, caregivers were required to provide informed consent before any data collection was started. Caregivers and children were then interviewed immediately before examination to obtain biographical information and history of any earache, ear discharge or hearing loss during a two-week period prior to the participation in the study and the data were recorded.

2.2. Otomicroscopy

Otomicroscopy was performed for each ear by an experienced (>35 years of practice) otologist using a Leica M525 F40 surgical otomicroscope with a 6:1 zoom magnification (1.2–12.8×) and a 300 W xenon fibre optic illumination. Cerumen was manually

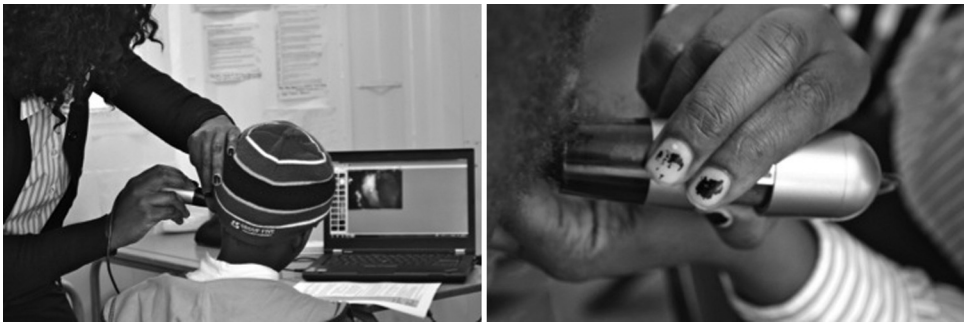

Fig. 1. Ear and hearing telehealth clinic facilitator documenting TM status with video-otoscopy.