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# Digital imaging and telemedicine as a tool for studying inflammatory conditions in the middle ear—evaluation of image quality and agreement between examiners

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Video endoscopy;
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**Summary**

*Objective:* To evaluate digital imaging of the tympanic membrane by telemedicine technology and study interpersonal agreement in assessing image quality.
*Methods:* In an open consecutive study, 64 children aged 2—16 years who attended three rural health care centres in Northern Sweden with otalgia were examined with video endoscopic photography of their tympanic membrane in a telemedical environment. One hundred and twenty-four images were stored in a central database and later assessed independently regarding image quality by an ENT specialist, a general practitioner and a registrar in general practice. The overall image quality was graded (0—2) regarding assessment of signs of tympanic membrane inflammation. All images were also assessed regarding 8 different components, four image-related components and four anatomically related components.
*Results:* Overall image quality was good, with 82.3% of acceptable or excellent quality. The position and thickness of the TM were found to be the most important factors of the images to be able to assess inflammatory disease. Image quality tended to be higher later in the study as a sign of improved skills of examiners. Interpersonal agreement between examiners was acceptable. Overall grade showed $\kappa$ 0.56, 0.49 and 0.66 respectively, and focus, light and existence of obscuring objects were the components with the highest agreement.

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*Conclusions:* The image quality of video endoscopy of the tympanic membrane was good overall. Interpersonal agreement in evaluating image quality was acceptable but not excellent. The use of digital imaging of good quality in clinical studies can offer an objective clinical evaluation of the TM in retrospect by independent reviewers using strict criteria.


## 1. Introduction

In the last few decades modern information technology has prepared the ground for the progress of telemedicine. Digital imaging and storage of images makes it easier to document different clinical situations of importance. Data can be sent and studies can be controlled and managed at long distance. In clinical trials videoconferencing technology can be used for coordination and communication which could save time and travel costs and increase the number of eligible patients [1,2]. Digital imaging technique has shown to be useful in the study of acute otitis media (AOM) [3]. A recent study conducted in rural Australia, indicates that endoscopic photography produced images of the tympanic membrane of good quality [4]. That study, however, was conducted with one examiner who compared in-person diagnostics with evaluation of images and other parameters in retrospect. In a study where video otoscope still images of TM were compared to in-person microscopic examination they found a high agreement between in-person examination and video-otoscope images in evaluation of transmyringal tubes but lower agreement on middle ear fluid and retraction of TM [5]. Interpersonal agreement was comparable when assessing video-otoscope images for these parameters. In a study comparing video-telescopy and pneumatic otoscopy and tympanometry on evaluating OME video-telscopy was found to have highest sensitivity and specificity compared to the latter two [6].

Inflammatory conditions in the middle ear are common among children and acute otitis media is the second most common infectious disease among children in Sweden and has for many years been the most frequent diagnosis for prescribing antibiotics [7]. The need for antibiotic treatment of all AOM is questioned and the natural course of AOM is insufficiently studied [8,9]. Recent research has shown that a higher diagnostic accuracy will lower the incidence of AOM and thereby lower prescribed antibiotics [9,11]. Consistency in diagnostic criteria between studies on AOM is weak, which makes it difficult to compare different studies [12], and studies made using photographic documentation are sparse.

Visualisation of the TM with for example otoscopy, together with verification of the presence of middle ear fluid is important to make a correct diagnosis [12]. Traditionally diagnostic myringotomy is used for evaluation of middle ear fluid [13]. Tympanometry is easier to use and is more convenient for the patient and has a high specificity but a lower sensitivity [10].

The aim of this paper was to assess the image quality and to analyze the importance of specific components of image quality in a multicentre study using digital imaging to evaluate the signs of inflammatory processes in the tympanic membrane in rural primary care settings. Furthermore we studied interpersonal variations in the judgement of image quality.

## 2. Methods

This study is a part of an open, consecutive and prospective study (to be published) in children aged 2—16 years attending with otalgia at three rural health care centres in the county of Vasterbotten. In this article we focus on describing and analyzing the method of digital imaging. The study was approved by the Regional Ethical Review Board in Umea at Umea University.

The connections between the different Health Care Centres (HCC) and the receiving unit at the Umea University Hospital are set up within Sjunet. Sjunet is a fibre-optical network protected by firewalls connecting Swedish health care systems apart from the Internet, IP based and built on Ethernet VLAN technology.

Each HCC was equipped with a PC-based telemedicine system (Migra Bildanalyssystem AB, Stockholm). The bandwidth for the network was 768 kbit/s. Software for image storage and analysis was used (Picsara). A straight fibre endoscope (Hopkins, by Karl Storz, 1218AT 0°) with a video camera attached (Karl Storz Endovision, Telecam® SL, 30 mm) was connected to the system. Detergent was used to avoid mist on the lens. Each health care centre was also equipped with an Entomed (Maico) Race Car Tympanometer (Fig. 1).

A PC-based protocol was developed in which anamnestic data, clinical findings, laboratory data