

# Pros and cons of traditional tympanometry: the customer's voice

Flavia Sorrentino<sup>1</sup>, Marco Greggio<sup>1</sup>

<sup>1</sup> Department of Neuroscience DNS, Otolaryngology Section, Padova University, Via Giustiniani 2, 35128 Padova, Italy

## Abstract

**Background:** the classic impedance test that uses pressure in the detection of the tympanogram and stapedial reflexes has represented for years the main procedure in determining the functionality of the middle ear; the aim of this paper is to highlight the main difficulties in the clinical performance of tympanometry reported by Italian technicians specialized in audiometry

**Methods:** a survey was administered to audiometrist technicians in two ways: direct interviews with technicians from various hospitals who practice in audiology and otolaryngology departments in the Veneto region recruited directly by us and a survey published in an online forum composed exclusively of personnel with a degree in audiometric techniques who could freely access and answer the survey

**Results:** We collected the data obtained from the compilation of as many as 60 questionnaires (all 60 technicians adequately filled in all the questions in the questionnaire). The most interesting points include the following difficulties reported: ensuring a stable pressure seal and making a correct choice of caps during the test, the execution of tympanometry in pediatric patients, the execution of tympanometry in patients with current otitis media or those who have recently undergone middle ear surgery

**Discussion:** The tympanometric examination is a pivotal test in the audiological diagnosis process; it is a fundamental test in the diagnosis of otological pathologies in both pediatric and adult patients. As emerged from our survey however, the current procedure is not free from problems and criticalities that clinicians must face on a daily basis that can influence the quality of the examinations in the diagnostic process.

## Introduction

The middle ear is an air-filled space located in the petrous part of the temporal bone. It is separated from the external ear by the tympanic membrane and from the inner ear by the medial wall of the tympanic cavity. It contains the ossicular chain that transmits and amplifies sound vibrations from the tympanic membrane to the inner ear.

Middle ear pathologies are frequent from childhood to adulthood. Early diagnosis is crucial in order to provide proper treatment and prevent serious complications.

Traditional tympanometry is the gold standard test to examine middle ear status. (British Society of Audiology, 1992)

Tympanometry is a test that provides information on the mobility of the middle ear system and the presence of fluid in the tympanic cavity by measuring how the middle-ear system responds to sound energy and how it reacts dynamically to variations in atmospheric pressure.

Various clinical conditions contraindicate the use of this method however, and the test procedure could be technically difficult depending on the operator, patient collaboration, and the technical characteristics of the instruments, which may change by producer brand.

The main aim of this paper is to detect the practical difficulties of traditional tympanometry and the critical issues of this method.

## Methods

The survey questions were processed by a team specialized in the field of otology and audiological diagnostics consisting of a physician, an audiometrist technician, and the collaboration of a company specialized in audiological diagnostic instrumentation. The survey consists of 10 closed-ended questions and one final open-ended question.

Fig. 1. The audiometrist survey questions pag. 1

1. ■ Do you think that choosing ear plugs for a correct use of the tympanometer is simple?  
 YES     NO

---

2. ■ Do you think that the pressure seal is easy to maintain?  
 YES     NO

---

3. ■ On a scale of 1 to 5, how much do you consider impedance measurement as an invasive test in pediatric patients? (1 indicates non-invasive at all, 5 very invasive)  
 1    2    3    4    5

---

4. ■ Do you think that a patient with current otitis media can feel pain when undergoing an impedance test?  
 YES     NO

---

5. ■ Do you think that impedance measurement is a simple test to perform with pediatric patients?  
 YES     NO

---

6. ■ Which of the following situations do you consider to be the one that may make the impedance test more difficult? Choose between pediatric age, elderly age, patient with an ongoing pathological situation (e.g. inflammation)?  
 1 Pediatric age  
 2 Elderly age  
 3 Ongoing pathological situation

---

7. ■ On a scale of 1 to 5, how simple do you consider the interpretation of the paths? (1 indicates very simple and 5 not simple at all)  
 1    2    3    4    5

Fig. 2. The audiometrist survey questions pag. 2

8. ■ Do you consider the maintenance of the impedance meter simple?  
 YES     NO

---

9. ■ Have you ever had patients who complained of suffering during the impedance test?  
 YES     NO

---

10. ■ Do you believe that the impedance test can be performed on a patient who has undergone middle ear surgery in the last year?  
 YES     NO

---

11. ■ Can you indicate three criticalities of the impedance meter that you use or that you have used in the past?  
 1. \_\_\_\_\_  
 2. \_\_\_\_\_  
 3. \_\_\_\_\_

---

12. ■ Notes and comments:

Closed-ended questions concern several peculiarities of tympanometric practice and are as follows (Figure 1-2):

Conclusive open-ended question Number 11 asks the respondent to indicate 3 criticalities of the impedance meter that he or she uses daily and to provide additional notes or comments.

The survey questions were all grouped in the "Google Forms" online platform. A specific questionnaire on which to directly enter the answers given by the clinicians was created.

The survey was therefore administered in two ways:

1) Direct in-person interviews with audiometrists who conduct professional activity in audiology and otolaryngology wards and clinics in the Veneto region; the answers were then reported directly by the audiometrists on the Google Forms online platform;

2) Publication of the survey in an online forum of professionals with degrees in audiometric techniques; audiometrists had direct access to the Google Forms' survey and could answer questions directly from their PC, tablet or smartphone with internet connection.

The survey was administered from 29 August 2022 and closed on 12 September 2022.

Once the questionnaires were completed, the results were automatically grouped and sorted into graphs by "Google Forms" platform for each question in the survey. The criticalities reported directly by audiometrists in response to Question 11 have also been grouped and those most reported have been highlighted.

## Results

A total of 60 audiometrists responded to the survey: 28 who practice in audiology and ENT departments in the Veneto region interviewed by us and 32 among the 800 members of the audiometrists taking part in the forum during the opening period of the survey. We provide the graphs illustrating the most important data that emerged from the survey and

that indicate the limits of classic tympanometric practice. (Figure 3-12).

Furthermore, among the critical issues most indicated by audiometrists on the daily use of the impedance meter (in response to Question 11), we highlighted four main problems (Figure 13):

As indicated by the graph, the problems commonly reported by clinicians in the use of the impedance meter are: pressure (21%), stapedial reflex (20%), probe (16%) and eartips (13%).

Fig. 3. Question 1: do you think that choosing ear plugs for a correct use of tympanometer is simple?



Fig. 4. Question 2: do you think that the pressure seal is easy to maintain?



Fig. 5. Question 3: on a scale of 1 to 5, how much do you consider impedance measurement as an invasive test in pediatric patients? ( 1 indicates non-invasive at all, 5 very invasive)

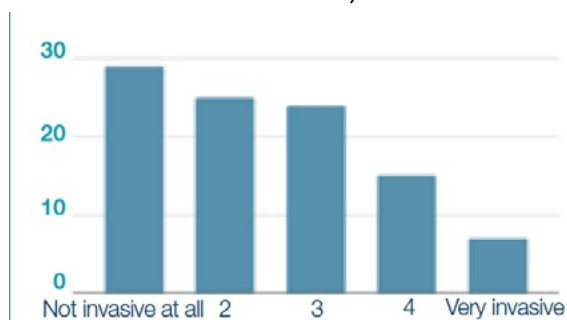


Fig. 6. Question 4: do you think that a patient with current otitis media can feel pain when undergoing an impedance test?



Fig. 7. Question 5: do you think that impedance measurement is a simple test to perform with pediatric patients?



Fig. 8. Question 6: which of the following situations do you consider to be the one that may make the impedance test more difficult? Choose between pediatric age, elderly age, patient with an ongoing pathological situation (e.g. inflammation)

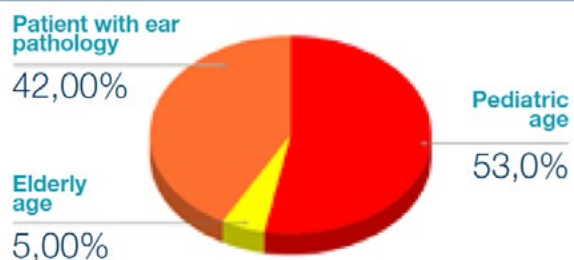


Fig. 9. Question 7: on a scale of 1 to 5, how simple do you consider the interpretation of the paths? ( 1 indicates very simple and 5 not simple at all)

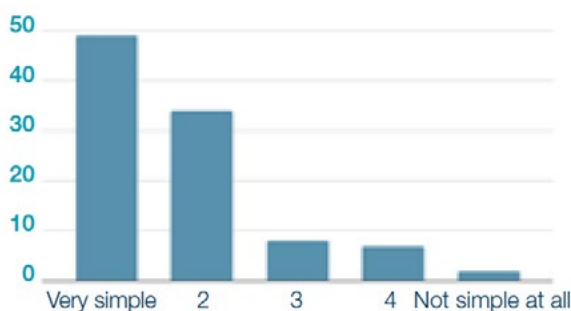


Fig. 10. Question 8: do you consider the maintenance of the impedance meter simple?

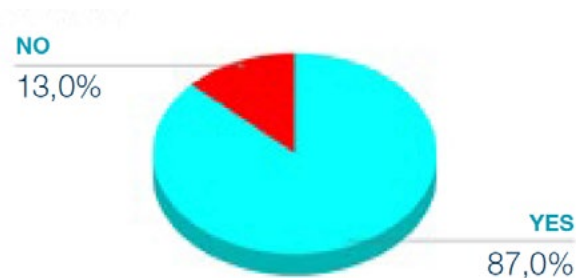


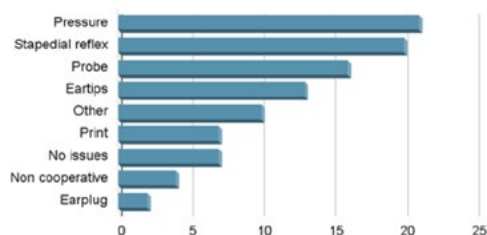
Fig. 11. Question 9: have you ever had atients who complained of suffering during the impedance test?



Fig. 12. Question 10: do you believe that the impedance test can be performed on a patient who has undergone middle ear surgery in the last year?



Fig. 13. Question 11: can you indicate three criticalities of the impedance meter that you use or that you have used in the past?



## Discussion

Traditional tympanometry is a clinical exam that can quickly and accurately detect the status of the middle ear. The data obtained are represented on a graph known as a “tympanogram” and classified using the universally recognized Liden-Jerger classification. For these reasons, traditional tympanometry has been extensively used worldwide for more than 50 years and its validity has been amply recognized at an international level.(Jerger J, 1970)

The exam was described as non-invasive. Its interpretation has been defined as simple by the majority of our respondents, as is also the maintenance of the tympanometer (Questions 3,7,8). In contrast, our analysis showed that there are several critical issues.

A certain variability was found in the answers to Questions 1 and 2 about the choice of the ear plug and the maintenance of the pressure seal. This shows that performing the test requires some experience and confidence with the instrument.

Moreover, 93% of interviewees answered that tympanometry is a painful examination in case of otitis media (Question 4), and 85% of interviewees declared that patients complained of suffering during the test (Question 9). This result is significant because even if tympanometry is non-invasive, it is an unpleasant test, especially under certain clinical conditions, and this could be a source of stress or anxiety for patients.

Another significant result regards the difficult execution of tympanometry on pediatric patients: the answers to Questions 5 and 6 indicate children as the most challenging patient category.

This finding is also important because it invites other considerations: given that the interviewees were audiometrist technicians, i.e., persons experienced in the practical execution of audiological tests, whenever a substantial proportion deems tympanometry difficult to apply on pediatric patients, it is only likely that less experienced health care professionals such as nurses or medical doctors (pediatricians, otolaryngologists or general practitioners) will encounter even more difficulties.(Lous J, 2012)

The survey brought another critical issue regarding the execution of tympanometry after middle ear surgery (Question 10) to light: classical tympanometry presents several clinical contraindications (Nakayama J.R, 2013), but there are no clear indications about if and when the test can be performed after “recent” middle ear surgery, probably because the answer depends on the surgery, the patient’s clinical situation, his or her clinical history, and on indications from the surgeon. These factors could justify the wide variability in audiometrists’ responses to Question 10 that brings confusion to this issue.

At the same time, this result confirms the extent to which previous surgery represents a limit to the tympanometry procedure, which in many cases is avoided in order to avoid running the risk of damaging the ear after the surgery.

Finally, our results show that there are a number of critical practical issues that render the exam more difficult in certain clinical situations (Question 11), and therefore it

is important that the persons executing the test be skilled, trained and experienced. This could be interpreted as a strength but also as a limit.

Despite the importance of this test in daily clinical practice, the clinical contraindications combined with the practical critical issues of tympanometry illustrate the need for new clinical tests and the development of a model that overcomes these limits while ensuring a comparable level of reliability at the same time.

## Conclusion

Tympanometry is the gold standard exam in measuring the input impedance or admittance of the middle-ear transmission system. The test presents certain clinical contraindications and technical limits in execution, however, which as our investigation has shown make it no longer totally compatible with the requirements of healthcare professionals.

## References

- Jerger J. (1970). Clinical experience with impedance audiometry. *Archives of otolaryngology* (Chicago, Ill. : 1960), 92(4), 311–324. <https://doi.org/10.1001/archotol.1970.04310040005002>
- Lous, J., Ryborg, C. T., Damsgaard, J. J., & Munck, A. P. (2012). Tympanometry in general practice: use, problems and solutions. *Family practice*, 29(6), 726–732. <https://doi.org/10.1093/fampra/cms045>
- Nakayama, J.R., Ramsey, M.J. (2013) Tympanometry. In: Kountakis, S.E. (eds) *Encyclopedia of Otolaryngology, Head and Neck Surgery*. Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-642-23499-6\\_742](https://doi.org/10.1007/978-3-642-23499-6_742)
- Recommended procedure for tympanometry. British Society of Audiology. (1992). *British journal of audiology*, 26(4), 255–257. <https://doi.org/10.3109/03005369209076644>