OTOSCOPY AND TYMPANOMETRY MANUAL

Minnesota Department of Health
Community and Family Health Division
Child and Adolescent Health Unit

OTOSCOPY AND TYMPANOMETRY MANUAL

Revised 3/2014

For more information, contact:

Minnesota Department of Health

Maternal and Child Health Section

Child and Adolescent Health Unit

PO Box 64882

St. Paul, MN 55164-0882

MDH C&TC website
http://www.health.state.mn.us/divs/fh/mch/ctc/

Revisions made to this manual are based on:

Guidelines for Hearing Screening After the Newborn Period to Kindergarten Age
http://www.improveehdi.org/mn/library/files/afternewbornperiodguidelines.pdf

American Academy of Audiology, Childhood Screening Guidelines
http://www.cdc.gov/ncbddd/hearingloss/documents/AAA_Childhood%20Hearing%20Guidelines_2011.pdf

American Academy of Pediatrics (AAP),Hearing Assessment in Children: Recommendations Beyond Neonatal Screening
http://pediatrics.aappublications.org/content/124/4/1252

CONTENTS

INTRODUCTION

This manual covers visual inspection of the ear, use of the otoscope, and tympanometry. It is a supplement to the Minnesota Department of Health (MDH) recommended hearing screening resources. This updated manual reflects the Guidelines for Hearing Screening After the Newborn Period to Kindergarten Age (January 2014) developed by a collaborative working group of the Early Hearing Detection and Intervention (EHDI) community advisory committee, including hearing and educational experts, and Child and Teen Checkups (C&TC) program staff.

For recommendations on other childhood hearing screening parameters and procedures, please refer to the following resources:

For information on hearing screening parameters for infants and children, refer to Hearing Screening Guidelines After the Newborn Period to Kindergarten Age.

For information on childhood hearing screening with pure tone audiometry refer to MDH Hearing Screening Training Manual.

For information on Child and Teen Checkups (C&TC) hearing screening requirements and recommendations, refer to Minnesota Child and Teen Checkups, Schedule of Age-Related Screening Standards and the Hearing Screening Online Training Program.

For information on otoacoustic emissions (OAE) hearing screening and online training resources, refer to Early Childhood Hearing Screening and Follow-up.

EAR EXAM AND OTOSCOPY

Visual Inspection

Ages

All ages

Purpose

To check for signs of ear disease or abnormal development

Description

A systematic inspection of the external ear canal, surrounding tissue, ear canal, and tympanic membrane

Equipment

External inspection: Adequate lighting

Internal inspection: Otoscope*

Procedure

External: Inspect the pinna and the area around it for any abnormalities such as preauricular sinuses, skin tags, or atresia; check for position (set or tilt)of the ears, tenderness, redness or edema, signs of drainage, foul odor, wax build-up in the outer ear canal, or dermatitis.

Internal: With the otoscope*, inspect the ear canal and tympanic membrane for signs of drainage, wax buildup, foreign bodies, redness of the ear canal, and other abnormalities; note presence or absence of normal tympanic membrane landmarks.

PASS

Children with normal appearance of all structures and no complaints of pain in the pinna or the tissue around the ear do not require referral.

REFER

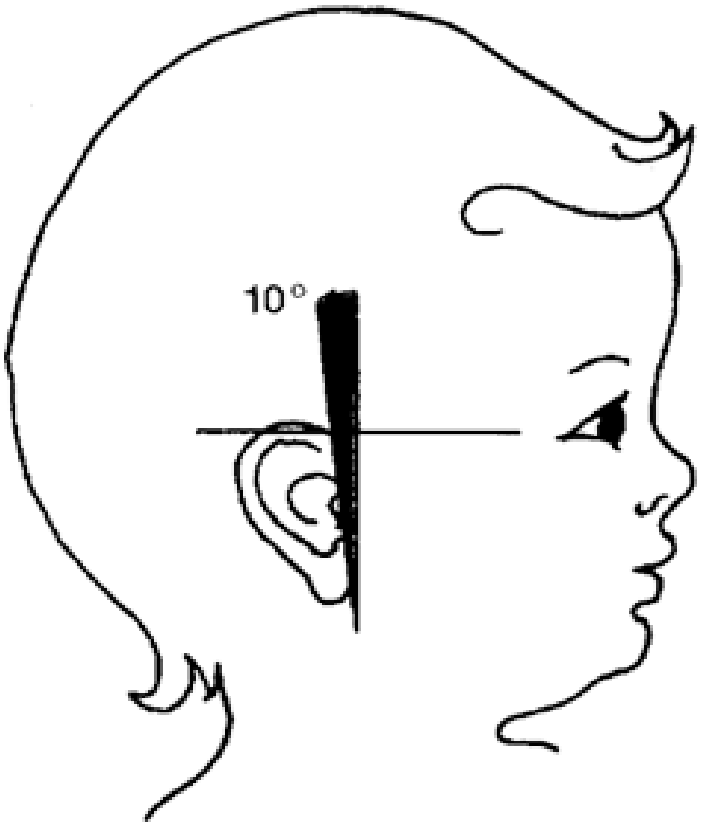
Refer children with any abnormality to a medical provider. **Do not** proceed with audiometer screening if tenderness, signs of drainage, or foul odor is present; this should be an automatic referral.

*If the screener has training and experience in using an otoscope. If the screener lacks training and experience in using an otoscope, the visual inspection should be limited to the external aspect of the ears.

External Inspection

Check for:

- Discharge
- Displacement
- Discoloration
- Deformity
- Pain



A child's ear position is normally set at a 10° tilt. Deviation from this position can be a clinical marker of syndromes associated with hearing loss.

Reprinted from Whaley LF, Wong DL, Nursing care of infants and children, 4th ed., Copyright 1991, Mosby, with permission from Elsevier.

Know Your Otoscope: Macroview Otoscope

An otoscope is an important tool for performing internal visual ear inspections. Below is an image of a macro view otoscope, with several key parts indicated by arrows.

Know Your Otoscope: Diagnostic Otoscope

An otoscope is an important tool for performing internal visual ear inspections. Refer below to an image of a diagnostic otoscope with several key parts indicated by arrows.

Know Your Otoscope: Speculums and Insufflator

Speculums and insufflators are parts of an otoscope. Below are images of the different types of speculums and an insufflator.

Commons sizes for disposable speculums, shown below, are:

- 2 mm (newborn)
- 3 mm
- 4mm
- 5 mm (adult)

Soft seal reusable tip

Insufflator bulb and tubing

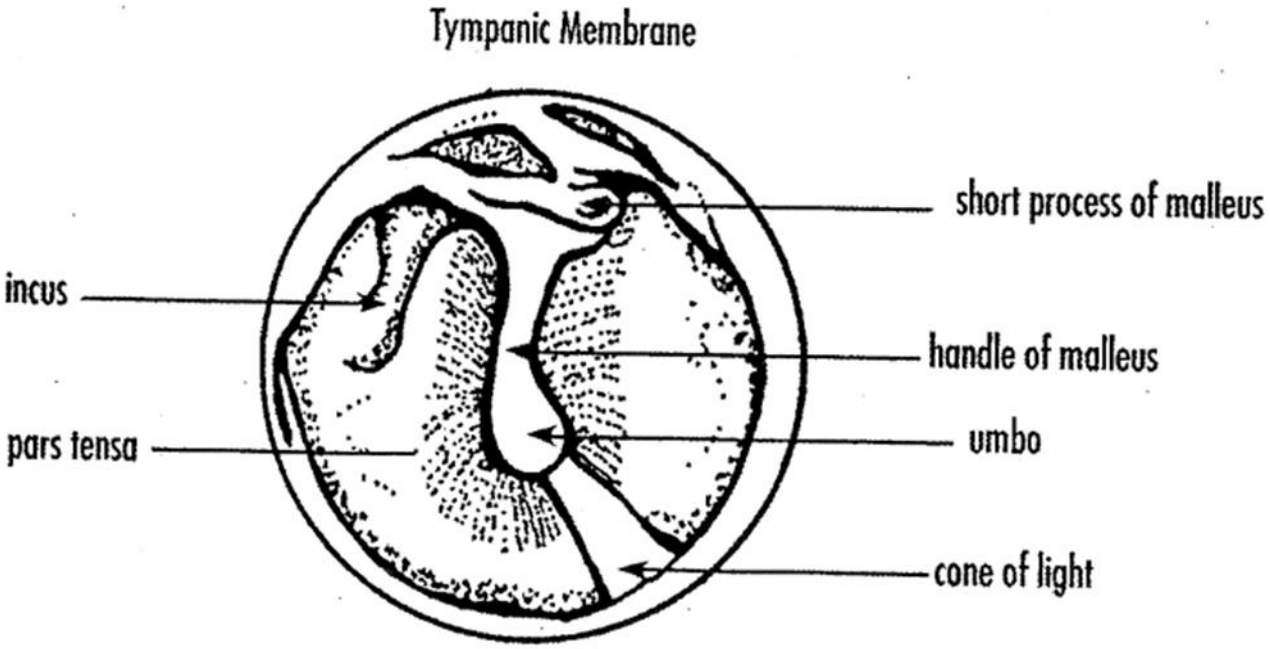
Internal Inspection With Otoscopy

Steps

1. Attach the otoscope head to the power base.
2. Choose the largest speculum that will allow you to see into the child's ear canal (usually a 3mm speculum) and twist the speculum onto the narrow end of the otoscope head in a clockwise direction.
3. Turn the otoscope on by pressing the colored button at the top of the power base and turning the otoscope head clockwise.
4. Check the ear canal for blockages or foreign bodies.
5. Hold the otoscope in your dominant hand with the thumb and first two fingers close to the otoscope head, and **the power base up**, much like holding a pencil.
6. Brace your hand against the child's head using your fingers or the heel of your hand to prevent trauma when the child moves.
7. Straighten the ear canal for best viewing.
    a. In children less than three years of age, grasp the earlobe and gently pull down and out.
    b. In children three and older, grasp the pinna and gently pull up and back to straighten the canal.
8. Watch carefully as you gently insert the speculum into the external canal.
    a. Direct the speculum upward in children three years or younger.
    b. Direct the speculum downward and forward in children three years or older.
9. Look into the magnifying lens and through the speculum. You should be able to visualize the external canal and tympanic membrane, as well as any cerumen or other obstacles.
10. You may use an insufflator bulb to visualize tympanic membrane mobility by placing the end of the tubing in the hole in the head of the otoscope and gently squeezing the bulb while looking into the ear canal.

What To Look For: Normal Findings

In addition to identifying the parts of the ear pictured below, examine the inner ear for foreign bodies and wax. Note the color the ear canal wall, the translucency and color of the tympanic membrane, and the presence, shape, and placement of the cone of light.



TYMPANOMETRY

Tympanometry Screening

Overview

Tympanometry measures ear canal volume (ECV), tympanic membrane mobility (compliance), and middle ear pressure (pressure). The ability to measure tympanic membrane mobility and middle ear pressure is useful in the assessment of middle ear condition and functioning, which can contribute to conductive hearing loss. It is not a screening for hearing, nor does it identify potential hearing loss.

Tympanometry is useful in identifying children who have fluid in their middle ear, which is a medical condition known as Otitis Media with Effusion (OME). OME is a condition that can be of varying duration, asymptomatic in up to 50% of children, and resolve spontaneously (Allen, Harlor, & Bower, 2009). OME is a common cause of conductive hearing loss. Studies assessing the degree of hearing loss in children, attributed to OME, have found screening results ranging from normal hearing to mild hearing loss. In these studies of children with OME, the median hearing screening results were a 25dB hearing loss for 500, 1000, 2000, 4000 Hz frequencies (American Academy of Family Physicians [AAFP] et al., 2004). There is no professional consensus on the impact that OME and temporary or fluctuating hearing loss have on language development or educational performance (AAFP, 2004).

The main function of tympanometry in a screening program is as a second stage screening for children who have a REFER on their immediate rescreen (American Academy of Audiology [AAA], 2011). Tympanometry can be useful in clarifying the possible cause of a REFER result. With this step, children who are more likely to have fluid (OME) in their middle ear can be differentiated from children who are more likely to be at risk of having permanent sensorineural hearing loss.

Tympanometry Screening Parameters

Tympanometry measures relative changes in movement and middle ear pressure by generating minute air pressure changes into the external ear canal. The procedure takes about five seconds to complete. A probe with a soft rubber cuff is positioned at the entrance to the external ear canal. The probe gently seals the ear canal while the machine emits a soft tone and air pressure within the canal changes. No response from the child is required to complete this screening. Results are automatically recorded onto a graph called a tympanogram. The graph represents the underlying condition and functioning of the tympanic membrane and middle ear pressure, which is displayed by the presence or lack of a curve.

The three parameters that determine this curve are: ear canal volume**,** tympanic membrane mobility noted as compliance, and middle ear pressure.

Ear Canal Volume (ECV)

ECV provides a measurement of air volume in the ear canal between the tympanometer probe tip and the tympanic membrane. This parameter is worth noting when the tympanogram lacks a curve.

Normal ECV measurements are:

- For a child < 12 years of age: 0.3 to 0.9 ml.
- For a child >12 years (or adult size): 0.3 to 1.4 ml.

Measurement Interpretation

- ECV measurement < 0.3 ml may indicate the probe is positioned against the side of the ear canal or against dense wax in the ear.
- ECV measurements > 2.0 ml may indicate that the volume measured is larger than the ear canal.
    - A patent PE tube or a perforation in the tympanic membrane can cause larger than normal ECV measurements.

Compliance

Normal middle ear function requires a mobile tympanic membrane to transmit sounds via vibrations to the three bones known as the ossicles (malleus, incus, and stapes, also known as the ossicular chain). These vibrations are transmitted via the ossicles to the cochlea.

Compliance is plotted vertically on the tympanogram. Maximum compliance of the middle ear system occurs when the pressure in the middle ear cavity is equal to the pressure in the external auditory canal. The maximum compliance value occurs at the highest peak of the curve on the graph.

The degree of compliance (tympanic membrane movement) is noted in milliliters (ml) as the height of the peak on the vertical axis of the tympanogram.

Normal compliance measurements are:

- For a child < 12 years of age: 0.2 to 0.9 ml.
- For a child > 12 years (or adult size): 0.3 to 1.4 ml.

Pressure

In a normal middle ear system, the Eustachian tube is open, allowing air to move in and out of the middle ear cavity. This air movement maintains the pressure in the middle ear equal to the pressure in the external ear canal. A blocked Eustachian tube can result in negative pressure in the middle ear, which can cause decreased mobility of the tympanic membrane. Eustachian tube dysfunction is the medical term for a blocked or non-functioning

Eustachian tube. Middle ear pressure is noted in deca Pascals (daPa) as the width (range) of the peak on the horizontal axis of a tympanogram.

Normal pressure measurements are:

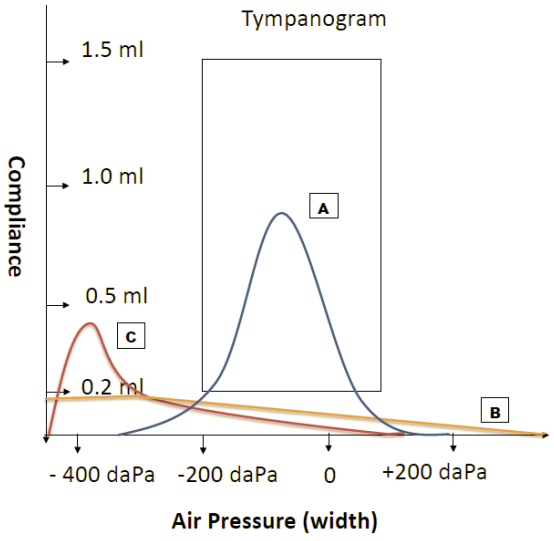
- For a child < 12 years of age: + 50 to - 200 daPa.
- For a child > 12 years (or adult size): + 50 to - 200 daPa.

Compliance and Pressure Measurement Interpretation

Typical tympanogram heights and widths, measuring compliance and pressure are classified into types depending on the shape of the peak. These types of peaks are also known as Jerger's gradients and are classified as types A, B, or C.

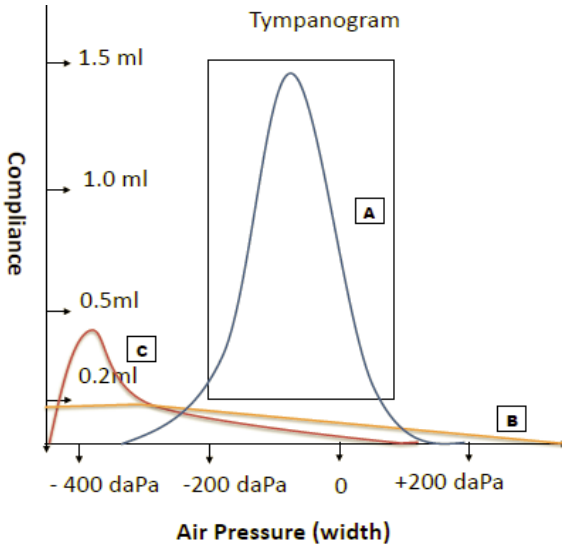
- An A type gradient is with in normal measurement parameters as set by MDH (AAA, 2011).
- Gradients B and C are considered abnormal and are classified as a REFER for the purposes of screening (refer to the diagrams below for sample tympanograms).

Child Tympanogram



Jerger Classifications
A: Normal
B: Abnormal middle ear function
C: Abnormal middle ear function

Adult Tympanogram



Jerger Classifications
A: Normal
B: Abnormal middle ear function
C: Abnormal middle ear function

* Note these parameters will need to be set on your tympanometer by either your audiologist or equipment company**.**

Tympanometry Procedure

Ages

Infants and children 6 months or older who REFER on their immediate hearing rescreen

Purpose

Assessment of middle ear function

Description

Measurement of tympanic membrane movement and middle ear pressure in response to varying air pressure

Equipment

Tympanometer

Facilities

Well lit area

Procedure

1. Perform otoscopy prior to tympanometry in order to identify conditions such as ear canal blockages, Pressure Equalization (PE) tubes, tympanic membrane perforation, or other obvious signs of external or middle ear disease.
2. It is recommended to have your machine set to indicate MDH passing parameters.
3. Instruct the child not to swallow or talk during the procedure.
4. Seal the external ear canal with the probe and start the tympanometry in accordance to your manufacturer's instructions.
5. Most machines will indicate when the ear has a proper seal.
6. Some machines will not perform the procedure until the ear canal is properly sealed.
7. Depending on the machine, there may be either a printout or a visual graph of the tympanogram on a screen that indicates the result and some machines will note if it is a PASS or REFER result.

PASS

If the child has a Type A tympanogram, this is a PASS result.

If a child has a **REFER result** on a hearing screen and a **PASS** on tympanometry either on immediate rescreen or at subsequent rescreens, they **require timely assessment by an audiologist and referral to, or notification of, the child's primary care provider.**

This action may depend on audiology access and the child's insurance status.

This child is at risk of having permanent hearing loss.

Rescreen/REFER

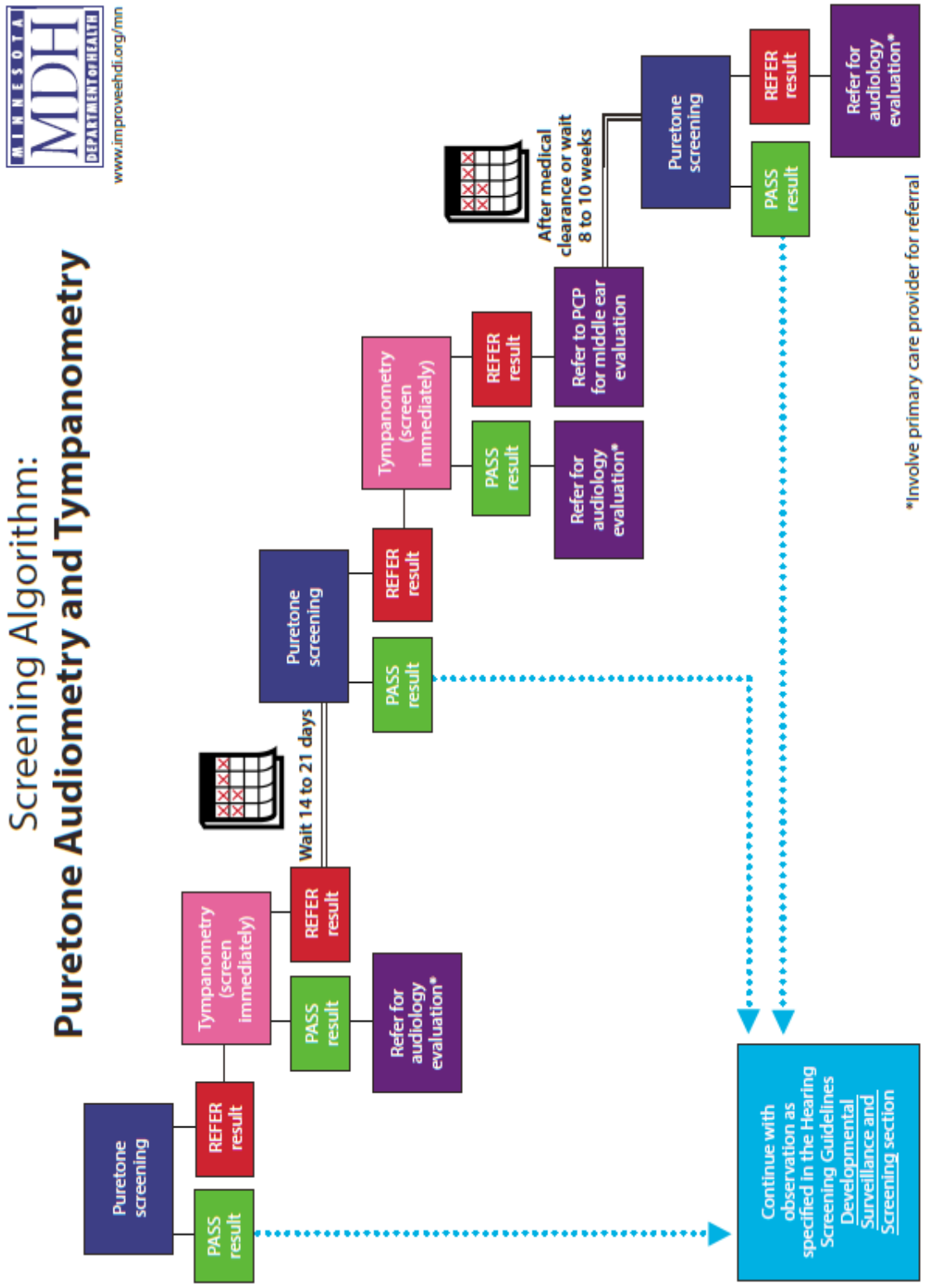
- If the child has Type B, C, or other tympanogram results outside the MDH recommended parameters, this is a REFER result.

- If the child has a **REFER** on both their hearing screen and tympanometry on **immediate rescreen,** rescreen in 14 to 21 days.
- If the child has a **REFER** on both their hearing screening and tympanometry at the 14 to 21 day rescreen or at subsequent rescreens, refer child to their primary care provider for middle ear evaluation and ongoing monitoring.

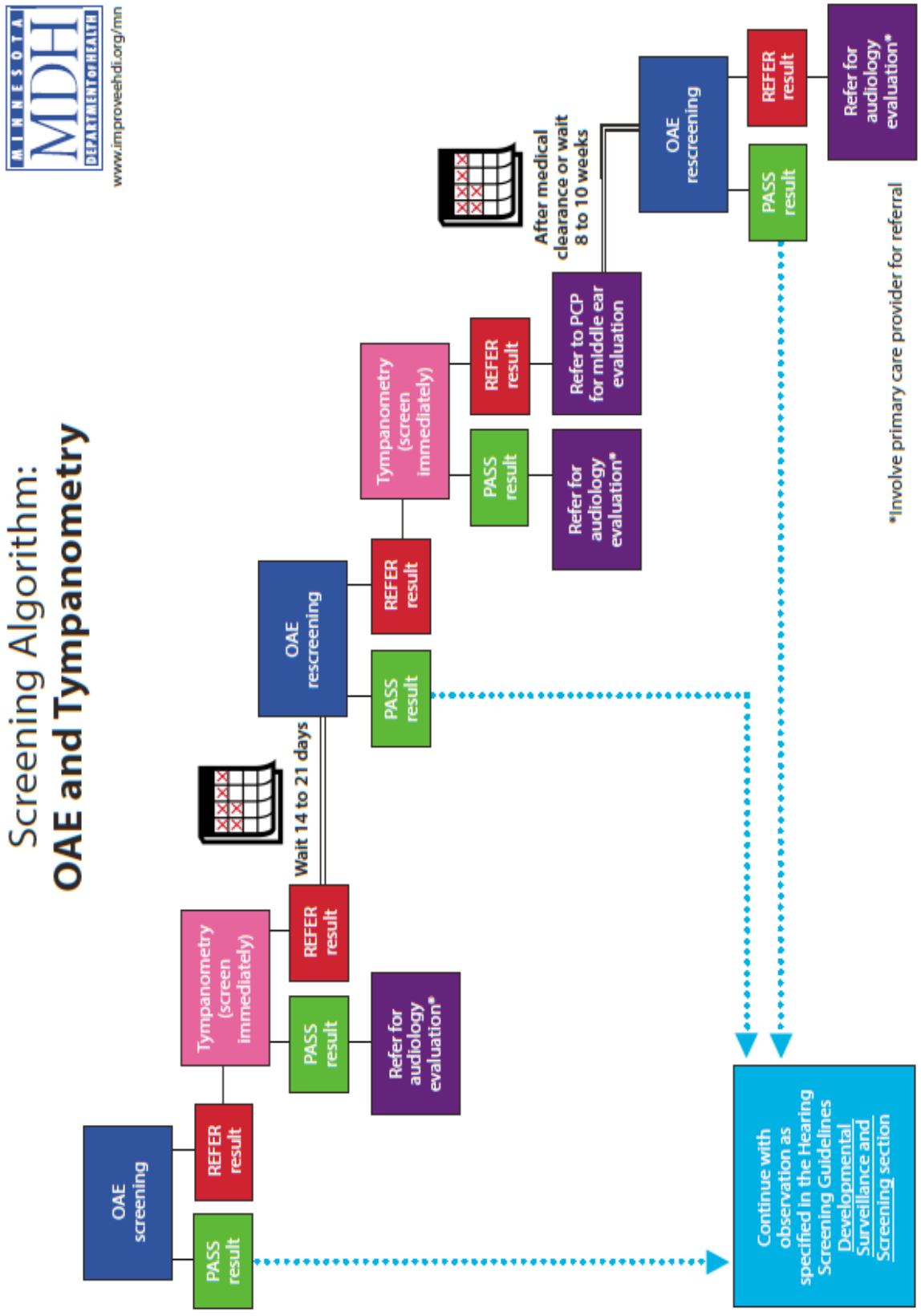
Refer to the following algorithms for further in formation

- *Pure tone audiometry and tympanometry*
- *OAE and tympanometry*

Screening Algorithm: Puretone Audiometry and Tympanometry



Screening Algorithm: OAE and Tympanometry



Equipment

Tympanometry equipment is useful for performing hearing screenings. It should quickly and easily provide measurements of compliance, ear canal volume, peak pressure and gradient. Programs should follow the manufacturer's manual recommendations in regards to maintenance and calibration.

When obtaining equipment, consideration must be given to portability, durability, ability to interface with older electrical outlets (not three pronged), and feasibility of maintaining battery powered units. The American Academy of Audiology recommends a 226 Hz probe tone frequency for screening preschool and school age children (AAA, 2011).

APPENDIX

Bibliography

American Academy of Audiology. (2011). Childhood hearing screening guidelines. Retrieved January 2013, from http://www.cdc.gov/ncbddd/hearingloss/documents/AAA_Childhood%20Hearing%20Guidelines_2011.pdf.

American Academy of Family Physicians, American Academy of Otolaryngology-Head and Neck Surgery and American Academy of Pediatrics Subcommittee on Otitis Media with Effusion. (2004). Otitis media with effusion. *Pediatrics,* 106(3)*,* 1411-1429.

Dhar, S. & Hall, J.W. (2010). *Otoacoustic Emissions; Principles, Procedures, and Protocols.* San Diego: Plural Publishing.

Engle, J. K. (2006). Mosby's pocket guide to pediatric assessment. St. Louis, MO: Mosby Elseveier.

Harlor, A., & Bower, C. (2009). Hearing assessment in infants and children: Recommendations beyond neonatal screening. *Pediatrics, 124*(4), 1252-1263.

Joint Committee on Infant Hearing. (2007). Year 2007 position statement: Principles and guidelines for early hearing detection and intervention programs. *Pediatrics*, 120(4), 898-921.

Online Hearing Resources

- MDH Online C&TC Hearing Training

  (www.health.state.mn.us/divs/fh/mch/webcourse/hearing/index.cfm)

- Guidelines for Hearing Screening After the Newborn Period to Kindergarten Age

  (http://www.improveehdi.org/mn/library/files/afternewbornperiodguidelines.pdf)

- Minnesota Child and Teen Checkups, Schedule of Age- Related Screening Standards

  (https://edocs.dhs.state.mn.us/lfserver/Legacy/DHS-3379-ENG)

- Early Childhood Hearing Screening and Follow-up

  (http://www.infanthearing.org/earlychildhood/)

Glossary

Atresia Closure or absence of the external auditory canal; imperforation, having no opening

Compliance A measurement of tympanometry, which depicts tympanic membrane mobility

Compliance peak The point on a tympanogram, which indicates maximum tympanic membrane mobility

Ear canal volume (ECV) Volume measured between the tip of the probe and the tympanic membrane at the start of the tympanogram

Gradient A graphic representation, shown as a wave with a peak, of the tympanometry measurements: compliance plotted on the vertical axis and pressure plotted on the horizontal axis

Peak The point of maximum tympanic membrane mobility noted on a tympanogram

Probe tone A low pitch (226 Hz for children 6 months and older.) tone used in a tympanometry screening to measure middle-ear mobility

Otitis media Inflammation of the middle ear and/or the tympanic membrane

Ossicles Malleus, incus, and stapes bones, located in the middle ear cavity; crucial to sound conduction

Preauricular sinus A tiny pit in the skin in the area where the outer rim of the ear (called the helix) attached to the face; preauricular sinuses can be an indicator of other ear problems

Pure tone audiometry A method of hearing screening used to identify children with suspected hearing loss by having the child listen to a series of pure tones and noting whether or not there is a response; considered the 'gold standard' of hearing screening

Skin tag A growth of skin tissue often near the ears, or elsewhere on the face or neck, is usually small, soft, and skin-colored; in rare cases skin tag(s) are associated with hearing problems

Threshold The softest (minimum) decibel at which an individual is able to respond to a tone (frequency) at least 50 percent of the time

Threshold audiometry A hearing test performed to determine thresholds at specific frequencies; MDH recommendations are to perform thresholds at 500, 1000, 2000, 4000, and 8000 Hz

Tympanic membrane A thin membrane between the external auditory canal and the middle cavity, which moves in response to sound waves and sets the ossicles bones in motion

Tympanogram A graphic representation of the numeric measures or tympanometry

Tympanometry An objective measurement of middle-ear mobility and middle ear pressure using sound (probe tone) and air pressure

Phone: (651) 201-3760

Fax: (651) 201-3590

If you require this document in another format,
such as large print, Braille, or audio recording, call (651) 201-3760.

Printed on recycled paper.

Rev. 3/2014