# Traumatic Brain Injury (TBI) Common Data Element (CDE) Outcome Measure Recommendations Version 2.0

## Outcome Domain:

Deafness and Other Communication Disorders

## Domain Description and Relevance in TBI:

This domain includes measures specifically recommended by the National Institute on Deafness and Other Communication Disorders (NIDCD) according to the mission areas of Hearing, Balance, Taste and Smell, and Voice, Speech, and Language.

Table CDE Classification by Type of TBI Study and Relevant Population for Recommended Deafness and Communication Disorder Measures

| Taste and Smell | Relevant TBI Population | Acute Hospitalized | Moderate/ Severe Rehabilitation | Concussion/ Mild TBI | Epidemiology |
| --- | --- | --- | --- | --- | --- |
| Taste and Smell Questionnaire (NHANES CSQ) | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |
| NIH Toolbox Taste Test | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |
| NIH Toolbox Odor Identification Test (OIT) | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |

Table CDE Classification by Type of TBI Study and Relevant Population for Recommended Deafness and Communication Disorder Measures

| Balance | Relevant TBI Population | Acute Hospitalized | Moderate/ Severe Rehabilitation | Concussion/ Mild TBI | Epidemiology |
| --- | --- | --- | --- | --- | --- |
| Dizziness Handicap Inventory (DHI) | Adult | Supplemental | Supplemental | Supplemental | Supplemental |
| NIH Toolbox Balance Accelerometry Measure (BAM) | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |
| NIH Toolbox Dynamic Visual Acuity Test | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |

Table Classification by Type of TBI Study and Relevant Population for Recommended Deafness and Communication Disorder Measures

| Hearing | Relevant TBI Population | Acute Hospitalized | Moderate/ Severe Rehabilitation | Concussion/ Mild TBI | Epidemiology |
| --- | --- | --- | --- | --- | --- |
| Hearing Handicap Inventory | Adult | Supplemental | Supplemental | Supplemental | Supplemental |
| Random-Gap Detection Test | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |
| SCAN-A and SCAN-C Auditory Processing Disorders Subtests | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |
| Time-Compressed Sentence Test | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |
| Tinnitus Functional Index (TFI) | Adult | Supplemental | Supplemental | Supplemental | Supplemental |
| Tinnitus Handicap Inventory (THI) | Adult | Supplemental | Supplemental | Supplemental | Supplemental |
| Words in Noise Test | Adult and Pediatric | Supplemental | Supplemental | Supplemental | Supplemental |

Table Classification by Type of TBI Study and Relevant Population for Recommended Deafness and Communication Disorder Measures

| Voice, Speech, and Language | Relevant TBI Population | Acute Hospitalized | Moderate/ Severe Rehabilitation | Concussion/ Mild TBI | Epidemiology |
| --- | --- | --- | --- | --- | --- |
| Voice Handicap Index (VHI) | Adult | Supplemental | Supplemental | Supplemental | Supplemental |

## Taste and Smell

### NHANES Chemical Senses – Taste & Smell – Questionnaire (NHANES CSQ)

### DESCRIPTION:

Individuals with taste and smell impairments may be at increased risk of health and nutritional problems and also at risk of safety problems from fire and gas explosions. Many factors contribute to taste and smell impairments, such as medications/drugs, radiation therapy, unhealthy habits (cigarette smoking), head trauma, chronic sinusitis and rhinitis, and some toxic environmental exposures. There is a great need to discover the extent of chemosensory problems, especially for older Americans, and to educate them (and caregivers) about potential hazards and ways to avoid these hazards. There is only one known population-based study in the United States that has measured olfactory function and reported on the prevalence of olfactory impairment. This study was performed in conjunction with the Epidemiology of Hearing Loss Study (EHLS), a study of sensory loss and aging in Wisconsin which had a sample size of 3,407 participants. There were two earlier prevalence studies of olfactory impairment in U.S. adults, the National Geographic Society Smell Survey, and the 1994 National Health Interview Survey (NHIS) – Disability Supplement. There were, however, drawbacks with both these earlier studies. The National Geographic Society study was not population-based and the smell examination tests were self-administered. The NHIS-Disability Supplement study was population-based, but ascertained chronic (3+ months) smell problems based on an interviewee’s self-reported responses during a home interview without any exam component. Both of these studies reported a much lower prevalence of smell impairments (about 2% for all adults and 5% for subjects aged 75+ years) compared to the examination-based Wisconsin study which found a smell impairment prevalence of 24.5% among adults 53+ years of age, and a prevalence of almost 30% among those aged 70–79 years.

The most common causes of permanent smell loss are upper respiratory infections, head trauma or injury, and chronic rhinosinusitis. Although the data are limited, these causes account for the majority of patients who present to physicians with chemosensory problems. Other less common causes of smell loss include chronic alcoholism, epilepsy, and neurological disorders such as multiple sclerosis, Alzheimer’s disease, and Parkinson’s disease. Exposure to a number of toxic chemicals can induce smell loss. Olfactory loss can occur as a result of exposure to air pollution and to chemical exposures in the workplace. In addition to directly damaging the smell receptors, some chemicals may produce damage indirectly by inducing upper respiratory inflammatory responses or infections that, in turn, cause damage. The best scientifically documented examples of smell loss due to chemical exposures in humans are for acrylates, methacrylates, and cadmium. It should be noted that tobacco smoke is known to have a high amount of cadmium.

The most debilitating taste disorders are those in which there is a persistent, chronic bad taste in the mouth, such as a bitter, salty, or “metallic” taste. The causes of this fall into two broad categories: (1) cases where an abnormal substance actually gains access to the mouth, and (2) “taste phantoms” that occur when there is nothing in the mouth. Taste phantoms originate in the brain itself. Tastants can enter the mouth in a number of ways (e.g., from metals in oral appliances, from infected discharge from the teeth or gums, from medications that enter the saliva, or from postnasal drip). Among offending medicines are lipid reducing agents, antibiotics, blood pressure medications, anxiety drugs, and antidepressants. Taste phantoms can result from tumors putting pressure on taste structures in the brain, but more commonly result from localized damage to the taste system. Inputs from the different nerves for taste normally interact with one another at the level of the brain and nerve damage can alter this process to produce taste phantoms. Fortunately, many of these problems resolve on their own over time due to the ability of the taste nerves to regenerate after damage.

The 2011–2012 National Health and Nutrition Examination Survey (NHANES) questionnaire is administered by Westat interviewers in the home to sample adults age 40+ years prior to inviting them to come to the NHANES Mobile Examination Center (MEC) for a half-day of exams, which includes chemosensory (Taste & Smell) exams. After reviewing other questionnaire instruments in the chemical senses, used in other population-based studies such as the Beaver Dam WI Offspring Study or in specialized Smell and Taste clinics, NIDCD staff and consultants in collaboration with staff of the National Center for Health Statistics (NCHS) developed and piloted the questionnaire, now known as the Chemical Senses – Taste & Smell Questionnaire (CSQ).

The following questions are included in the CSQ:

* During the past 12 months, have you had a problem with your sense of smell, such as not being able to smell things or things not smelling the way they are supposed to?
* Do some smells bother you although they do not bother other people?
* Do you sometimes smell an unpleasant, bad or burning odor when nothing is there?
* How long ago did you first notice a problem with, or change in, your ability to smell?
* Is the problem with your ability to smell always there or does it come and go, for example, with a cold?
* During the past 12 months have you had a problem with your ability to taste sweet, sour, salty or bitter foods and drinks?
* Is your ability to taste food flavors such as chocolate, vanilla or strawberry as good as when you were younger?
* During the past 12 months have you had a taste or other sensation in your mouth that does not go away?
* Would you describe the taste in your mouth that does not go away as… sweet, sour, salty, bitter, metallic, burning or tingling, bad or foul, or something else?
* How long ago did you first notice a problem with, or change in, your ability to taste?
* Have you ever discussed any problem with, or change in, your ability to taste or smell with a health care provider {include doctors, dentists, dietitians, and nutritionists as health care providers}?
* When was the last time you discussed any problem with your ability to taste or smell with a health care provider?
* During the past 12 months, have you tried any treatments to improve your ability to taste or smell?
* During the past 12 months, have you experienced a problem with your general health, work, or enjoyment of life because of a problem with your ability to taste or smell?
* During the past 12 months, have you had any of the following
  + A head cold or flu for longer than a month?
  + Persistent dry mouth (not enough saliva)?
  + Frequent nasal congestion from allergies?
* Have you ever had any of the following
  + Wisdom teeth removed?
  + Tonsils removed?
  + Loss of consciousness because of a head injury?
  + Broken nose or other serious injury to face or skull?
  + Two or more sinus infections?

In recognition of their general public health importance, the Federal Interagency Workgroup for Healthy People 2020 has added taste and smell disorder-related goals to its surveillance monitoring agenda. This is in recognition of the disabling health consequences of the loss of the normal ability to smell and taste. Specific Healthy People 2020 goals include: (1) increase the proportion of adults with chemosensory (smell or taste) disorders who have seen a health care provider about their disorder in the past 12 months; (2) increase the proportion of adults who have tried recommended methods of treating their smell or taste disorders in the past 12 months to improve their condition; and (3) reduce the proportion of adults with chemosensory (smell or taste) disorders who as a result have experienced a negative impact on their general health status, work, and other daily activities, or quality of life in the past 12 months. The NHANES household interview questionnaire CSQ, together with the NHANES chemosensory exam component, will support monitoring of all three goals in Healthy People 2020.

#### PERMISSIBLE VALUES:

Questions with multiple response options can be grouped into categories for analysis or analyzed independently with other outcome measures. There is no overall score.

The NHANES/NIDCD Chemical Senses Questionnaire is available at: [CHEMICAL SENSES – TASTE & SMELL – (CSQ)](http://www.cdc.gov/nchs/data/nhanes/nhanes_11_12/csq.pdf)

### PROCEDURE:

This CSQ questionnaire is currently administered in the subject’s home by NHANES (Westat) interviewers using CAPI (computer-assisted personal interview) technology on a laptop.

#### COMMENTS:

Applicable to adults; should be applicable to adolescents as well.

#### RATIONALE:

It is critically important to collect questionnaire data from subjects about their Taste and Smell disorders, i.e., symptoms and complaints, in addition to conducting olfactory (smell) and gustatory (taste) exams. The NHANES chemosensory data will be available for widespread use by researchers interested in Taste or Smell disorders, including symptoms and complaints, examination results, and a variety of potentially important associations with nutritional intake data, body mass index (BMI) measurements, and many chronic conditions (e.g., diabetes, cardiovascular disease, etc.). The number of studies using this tool is expected to grow. Documentation is available and training of interviewers is a minimal expense.

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### NIH Toolbox Taste Test

#### DESCRIPTION:

The NIH Toolbox Taste Test for older children, ages 12–17 years, and adults, ages 18–85 years, is a spatial (regional) test to assess variability in perceived intensity of aqueous quinine hydrochloride (bitter) and sodium chloride (salty) when applied to the tongue tip as well as when perceived with the whole mouth. Intensity scaling was selected as the methodology for use in children and adults. Gustation consists of the perception of sensations that are usually described as having one or more basic taste qualities: sweet, salty, sour, bitter, or *umami* (savory/brothy). These sensations facilitate consumption of nutrients (e.g., sweet for calories, salty for sodium) and contribute to rejection of toxins (bitter). The gustatory system contributes to the perception of food flavor blending with olfactory, texture, and irritation sensations. Hypo- or hyper-response to the perceived intensity of quinine and sodium chloride can be used to characterize differences in individual’s food preferences, which guide food selection, and ultimately health and chronic conditions such as obesity, diet-related cancers, and heart disease. Because of time restrictions in the NIH Toolbox, the perceived intensity of aqueous sucrose (sweet) was not included or normed. However, the Taste team agreed that assessments of bitter, salty, and sweet taste perception are important.

*Assessing Perceived Intensity* – A general Labeled Magnitude Scale (gLMS) is recommended for all taste intensity scaling tasks because it has the ability to distinguish a range of taste perception from low or dysfunctional to extremely intense – some individuals perceive selected tastants as extremely intense – they are referred to as “supertasters”. The directions for the gLMS encourage participants to report the perceived intensity of the tastants relative to the intensity of other sensations (i.e., generalized scale), increasing the validity of perceptual ratings and the comparison of ratings across individuals. Furthermore, an instructional set has been established that provides brief and consistent training on use of the gLMS and promotes ease of use in older adults. The NIH Toolbox Taste team recognized that this scale may not be appropriate for young children aged less than 12 years.

The NIH Toolbox Taste Test can differentiate variability in taste intensity associated with genetic differences and environmental conditions. Genetic differences in taste receptor function or expression account for some, but not all, of the individual differences in taste perception. Other differences may be due to the density of papillae on the tongue surface, or environmental factors such as damage to the nerves innervating the oral cavity. For example, the chorda tympani branch of the facial nerve, which innervates the anterior two thirds of the tongue, is vulnerable to damage from pathogens and trauma because of its anatomical location. Extending along the medial surface of the tympanic membrane in the middle ear, the chorda tympani nerve joins the lingual nerve before passing within the soft tissue of the mandible. This location makes the nerve susceptible to damage from ear infections, middle-ear surgeries, jaw injuries, and dental procedures. Because three different cranial nerves (facial, glossopharyngeal, and vagal) innervate taste receptors in the oral cavity, it is difficult to detect localized taste loss by whole-mouth assessment alone. Although damage to the taste component of the chorda tympani nerve can diminish taste intensity from the anterior tongue, the loss may be unnoticed due to release of inhibition from other oral sensory cranial nerves, thereby increasing bitter, touch, and irritation from stimuli perceived with the whole mouth. However, damage to the chorda tympani can be detected by isolating taste stimulation to the anterior portion of the tongue (regional application of tastants) and comparing taste intensity on the tongue tip to the intensity of taste when perceiving with the whole mouth as during eating. Furthermore, damage to the chorda tympani nerve can lead to the perception of taste phantoms (dysgeusia) and is thought to lead to the perception of oral pain phantoms as well.

#### PERMISSIBLE VALUES:

The gLMS score (range 0-100) is read from a mark on a vertical line placed by the subject or examinee. Alongside the vertical line, there are descriptions (strongest sensation of any kind, very strong, strong, moderate, weak, barely detectable, and no sensation). The subject is free to mark any location on the line, but is reminded to bracket his/her gLMS intensity ratings between the two most appropriate descriptors, e.g., between very strong and strong, or between weak and barely detectable, etc. The spacing of the descriptors beside the line appear to be approximately logarithmic, e.g., strongest imaginable is at the top of the scale at 100, while very strong is about 53, strong is about 35, moderate is about 17, weak is about 6, barely detectable about 1, and no sensation is 0. These numerical scores are not visible on the computer screen for the NIH Toolbox Taste intensity ratings. The marks on the vertical line, or “raw” gLMS scores, are recorded electronically for the perceived intensity of the remembered light intensities and for each of the four trials (quinine on tongue tip, salt on tongue tip, quinine whole mouth [sip, spit, rate, and rinse], and salt whole mouth [sip, spit, rate, and rinse]).

#### PROCEDURE:

Before using the gLMS scale to assess tastants, subjects are asked to correctly rank light intensities in practice trials, viz., the intensity of light in a dimly (candle)-lit restaurant versus the intensity of light in a well-lit room versus the intensity of the strongest/brightest light they have ever seen. If subjects are unable to do this scaling task (rank ordering) correctly, they are excluded from the Taste test. Having the subjects rate the light standards is also intended to reinforce that the gLMS is a general scale and that the adjective labels apply to sensations of any kind, not just to taste sensations.

Subjects are asked to extend their tongues while either salt or quinine solutions are painted across the tip of the tongue; after the application of the tastant and before the subject puts the tongue back in his/her mouth, the subject rates the intensity using the gLMS, then rinses his/her mouth out with water. Small (unmarked) containers of quinine and salt solutions are presented to the subject for sipping and swishing around in his/her mouth for several seconds, before spitting. After spitting, the subject rates the intensity using the gLMS, then rinses his/her mouth out with water before continuing. The Taste test can be administered in 4 to 8 minutes, including the time needed to explain the gLMS scaling procedure and rating of intensity of the remembered light sensations.

#### USING THE RATINGS TO ASSESS TASTE FUNCTIONING:

The Taste team recommends using the gLMS scores for quinine whole mouth and salt whole mouth intensity ratings, separately, to evaluate overall gustation intensity. For example, an individual with TBI could have depressed tongue tip taste ability (<weak) yet perceive the bitter and salt tastes much more intensely with the whole mouth (>strong), or if severe damage to taste-related cranial nerves, have depressed intensity of both tongue tip and whole mouth perception (<weak). These two scores can be referenced to the norming sample T-scores (with adjustments available for age and other factors). Other combinations of the four gLMS scores can be used to identify spatial (regional) taste loss, including ratios of quinine intensities on tongue tip versus whole mouth. The remembered light intensities can be used to mathematically normalize the taste intensity ratings or used as a covariate in statistical analysis to partition out variance associated with individual differences in use of the scale.

#### COMMENTS:

Applicable to children age 12–17 years and adults 18–85 years.

#### RATIONALE:

The NIH Toolbox Taste Test is recommended for use in a wide variety of settings. There are extensive norming data available based on this tool and its use is expected to grow. The protocol for Taste testing implemented in the 2012 National Health and Nutrition Examination Survey (NHANES), funded by NIDCD, is very similar; however, the NHANES exam includes two different concentrations of salt solutions in addition to quinine. Documentation and training videos are available and the cost and availability of materials (tastant solutions) has been carefully considered by the NIH Toolbox Taste Team.

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## NIH Toolbox Odor Identification Test (OIT)

#### DESCRIPTION:

The NIH Toolbox OIT consists of 5 odors for young children, ages 3–9 years, and 9 odors for older children and adults, ages 10–85 years, to test the subject’s ability to identify common smells/odors. Our sense of smell provides us with information about our air, water, and food that is critical to our health and safety, nutrition, and psychological well-being. The test odors (odorants) are micro-encapsulated and placed onto individual small cards. After scratching the card and sniffing, subjects are asked to choose the best match for each odor from four pictures, representing the correct choice and three “wrong” or distractor odor sources. Prior to performing the test, to ensure familiarity with the pictured odor sources, children under the age of 10 were asked to point to the correct picture (including both correct target odors and distractors) when the examiner named them. If the young children make an error, they are shown the correct answer and re-tested on those items incorrectly identified. This is an important step because odor identification tasks depend not only on the ability to smell, but familiarity with the odor stimulus, which will vary with age and experience. The 5 odors for young children are: Play Doh™, chocolate, lemon, popcorn, and bubble gum. The 4 additional odors for older children and adults are: flower, coffee, natural gas (mercaptan), and smoke. The mean percent correct score for older children and adults was above 75% except for the oldest subjects, 70+ years of age. The best performance was for young adults, aged 18–29 years (n=265), with a mean percent correct score of 8 (88.9%), with a standard deviation of 1.66. Norms are available based on a sample of 2,884 older children and adults, ages 10–85, examined at multiple sites across the United States. No agreement has yet been reached, but a scoring scheme can be suggested. For example, it is likely that for older children and adults a score of 0–3 out of 9 odors (<33%) may be labeled “severe” olfactory impairment, while a score of 4 correct out of 9 (44.4%) may be labeled “moderate” olfactory impairment, a score of 5 out of 9 (55.6%) may be labeled as “mild” olfactory impairment, and 6 out of 9 (66.7%) may be labeled “slight” olfactory impairment. Percent correct scores of 7, 8, or 9 (77.8%, 88.9%, or 100.0%) may be considered “good to excellent” olfactory scores. The suggested schema is analogous to the frequently-used classification of degree of hearing impairment, which is judged in comparison to the hearing of healthy young adults, and not adjusted to be age-appropriate. Studies of multiple sensory impairments, for example, subjects having combinations of vision, hearing, olfactory, and gustatory (taste) impairments, have shown that each of these senses have separate, independent associations with quality of life measures.

#### PERMISSIBLE VALUES:

A total score (range 0-5) for young children ages 3–9 years and (range 0-9) for older children and adults ages 10–85 years. This is a quick screening test, available from the NIH Toolbox (contact: [NIH Toolbox](http://www.nihtoolbox.org/Pages/default.aspx)). If more thorough testing is desired, the full University of Pennsylvania smell identification test (UPSIT) based on 40 odors, can be employed.

#### PROCEDURE:

Patient completes scratch-and-sniff odor identification test by matching the odor sniffed to a picture displayed on a computer screen, selecting from among 4 items displayed in a forced choice paradigm. The test can be administered in 5 minutes or less.

#### COMMENTS:

Applicable to children and adults.

Several alternative brief odor identification tests are available, including the following:

* Simple olfactory screening test (stimulant is a 70% isopropyl alcohol pad presented to the nose with eyes closed; distance from nose when subject detects the odor is correlated with the degree of olfactory loss; can differentiate between unilateral or bilateral losses)
* Cross-Cultural Smell Identification Test (CC-SIT) with 12 odorants
* Brief Smell Identification Test (BSIT) with 12 odorants (identical to the CC-SIT)
* San Diego Odor Identification Test (SDOIT) with 8 odorants
* Sniffin’ Sticks (developed in Germany, often used in Europe) with 7 to 16 odorants
* NHANES 2012, based on two different Pocket Smell Identification Tests with 8 odorants

#### RATIONALE:

The NIH Toolbox OIT is recommended for use in a wide variety of settings. There are already studies using this tool and its use is expected to grow. Documentation and training videos are available and the cost of materials has been minimized.

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## Balance

### Dizziness Handicap Inventory (DHI)

#### DESCRIPTION:

The DHI consists of 25 items that query a patient’s symptoms of dizziness or unsteadiness. Patients are instructed to respond “yes,” “sometimes,” or “no” regarding whether they were recently bothered by a particular symptom. Questions fall into one of three domains: functional, physical, or emotional. Summation of total scores results in an assessment of the handicap as mild, moderate, or severe.

#### PERMISSIBLE VALUES:

A total score (range 0-100) and scores for the subscales Functional (0-36), Physical (0-28), and Emotional (0-36)

#### PROCEDURE:

Patient completes questionnaire. Can be administered in under 5 minutes.

#### COMMENTS:

Applicable to adults

#### RATIONALE:

The DHI is commonly used to assess severity of dizziness, one of the most common sequelae of mild TBI.

#### REFERENCES:

Jacobson GP, Newman CW: The development of the Dizziness Handicap Inventory. Arch Otolanryngol Head Neck Surg 1990, 116:424-427.

### NIH Toolbox Sensory Battery: Dynamic Visual Acuity Test and Balance Accelerometry Measure

#### DESCRIPTION

The following NIH Toolbox Sensory Battery subtests are recommended in this domain:

* NIH Toolbox Dynamic Visual Acuity Test
* NIH Toolbox Balance Accelerometry Measure (BAM)

The Sensory Battery is further described under the Outcome Domain Physical Function.

#### PERMISSIBLE VALUES

Under development

#### PROCEDURE

Technician will provide instructions and participant will be required to perform on functional tasks. Administration time should be 30 minutes or shorter.

#### COMMENTS

The battery is designed to be used in large epidemiological studies and in clinical trials for ages 3 to 85.Should be able to examine broad range of normal functions. Will be tested in large samples of individuals from the general population. However, has not been yet validated in TBI.

#### RATIONALE

Designed as part of the NIH Blueprint initiative for use in NIH research involvinglarge epidemiological studies and clinical trials. The battery will examine various sensory skills, will be at nominal cost and will take no more than 30 minutes to complete. Large standardization is being planned.

#### REFERENCES

[NIH Toolbox](http://www.nihtoolbox.org/Pages/default.aspx) Principal Investigator: Richard Gershon PhD e-mail -mail: gershon@northwestern.edu

## Hearing

### Hearing Handicap Inventory

#### DESCRIPTION:

The Hearing Handicap Inventory consists of 25 questions on the degree of handicap a patient experiences due to hearing problems. There are separate versions for younger and older adults. There is an emotional subscale and a social/situational subscale. Each item is scored 4=Yes, 2=Sometimes, 0=No.

#### PERMISSIBLE VALUES:

0 – 100

#### PROCEDURE:

Self-report

#### COMMENTS:

Adults

#### REFERENCES:

1. Ventry IM, Weinstein BE. The hearing handicap inventory for the elderly: A new tool. Ear Hear 1982;3:128-134.
2. Newman CW, Weinstein BE, Jacobson GP, Hug GA. The Hearing Handicap Inventory for Adults: psychometric adequacy and audiometric correlates. Ear Hear 1990;11:430-433.
3. Newman CW, Weinstein BE. The Hearing Handicap Inventory for the Elderly as a measure of hearing aid benefit. Ear Hear 1988;9:81-85.
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5. Zecker SG, Hoffman HJ, Frisina R, Dubno JR, Dhar S, Wallhagen M, Kraus N, Griffith JW, Walton JP, Eddins DA, Newman C, Victorson D, Warrier CM, Wilson RH: Audition Assessment Using the NIH Toolbox. *Neurology* 2012 (in press).

### Random-Gap Detection Test

#### DESCRIPTION:

The Random-Gap Detection Test (RGDT) is a component of Central Auditory Processing testing and tests the patient’s ability to detect gaps in tonal and click stimuli. The test is available on CD. Seven sections include 2 practice sessions and stimuli of set frequency and duration, separated by varying inter-stimuli intervals.

#### PERMISSIBLE VALUES:

GapDetection Threshold in msec

#### PROCEDURE:

A CD is used to administer the test

#### COMMENTS:

Adults and children over the age of 7.

#### REFERENCES:

Keith RW: Random gap detection test (RGDT). St. Louis: Auditec, 2000

### SCAN-A and SCAN-C Auditory Processing Disorders Subtests

#### DESCRIPTION:

TheSCAN-A and SCAN-C test batteries contains auditory processing disorder tests normed for children and adults. The battery includes screening and diagnostic tests. Thefollowingtests are recommended:

* Filtered Words Test
* Auditory Figure-Ground Test
* Competing Words Test
* Competing Sentences Test

#### PERMISSIBLE VALUES:

Normed scores

#### PROCEDURE:

Administered by audio CD and paper-and-pencil

#### COMMENTS:

Adults and Children

#### REFERENCES:

Keith RW: Development and standardization of SCAN-C test for auditory processing disorders in children – revised. J Am Acad Audiol 2000; 11:438-445. Keith RW: SCAN-A. Test for auditory processing disorders in adolescents and adults. San Antonio: Psychological Corporation, 1994.Time-Compressed Sentence Test

#### DESCRIPTION:

The Time-Compressed Sentence Test is a component of Central Auditory Processing testing and consists of audio of sentences which are compressed at 40%, 60%, or not at all. The test is used to identify temporal processing disorders. There is one practice subtest and four scored tests in all.

#### PERMISSIBLE VALUES:

Age norms

#### PROCEDURE:

A CD is used to administer the test. Completed in under 10 minutes.

#### COMMENTS:

Adults and children

#### REFERENCES:

Keith RW: Time-compressed sentence test. St. Louis: Auditec, 2002Tinnitus Functional Index (TFI)

#### DESCRIPTION:

The TFI is a 25 item questionnaire that assesses a patient’s tinnitus symptoms over the past week. The recently developed scale has demonstrated validity and responsiveness to change. It covers a variety of domains possibly affected by a patient’s tinnitus.

#### PERMISSIBLE VALUES:

A total score ranging from 0-100, and scores for the following subscales: Intrusive (0-30), Sense of Control (0-30), Cognitive (0-30), Sleep (0-30), Auditory (0-30), Relaxation (0-30), Quality of Life (0-40), and Emotional (0-30)

#### PROCEDURE:

Self-report questionnaire

#### COMMENTS:

Applicable to adults

#### RATIONALE:

A recently developed measure that can capture tinnitus symptoms in TBI patients and its effects on quality of life.

#### REFERENCES:

Meikle MB, Henry JA, Griest SE, Stewart BJ, Abrams HB, McArdle R, Myers PJ, Newman CW, Sandridge S, Turk DC, Folmer RL, Frederick EJ, House JW, Jacobson GP, Kinney SE, Martin WH, Nagler SM, Reich GE, Searchfield G, Sweetow R, Vernon JA. The tinnitus functional index: development of a new clinical measure for chronic, intrusive tinnitus. Ear Hear. 2012 Mar-Apr;33(2):153-76.

Investigators should register to use the TFI at the following link: [Tinnitus Functional Index (TFI)](http://www.ohsu.edu/xd/health/services/ent/services/tinnitus-clinic/tinnitus-functional-index.cfm)

### Tinnitus Handicap Inventory (THI)

#### DESCRIPTION:

The THI is a 25 question inventory relating to a patient’s tinnitus. Patients respond “yes,” “sometimes,” or “no” to a series of queries regarding their symptoms. Scores range from Grade 1 – slight or no handicap to Grade 5 – catastrophic handicap.

#### PERMISSIBLE VALUES:

Total score ranges from 0-100

#### PROCEDURE:

Patient completes questionnaire. Can be administered in under 5 minutes.

#### COMMENTS:

Applicable to adults

#### RATIONALE:

The THI is a commonly used measure for assessing the severity of tinnitus.

#### REFERENCES:

Newman, C. W., Jacobson, G. P., & Spitzer, J. B. (1996). Development of the Tinnitus Handicap Inventory. Arch Otolaryngol Head Neck Surg, 122, 143-148.

McCombe, A., Bagueley, D., Coles, R., McKenna, L., McKinney, C. & Windle-Taylor, P. (2001). Guidelines for the grading of tinnitus severity: The results of a working group commissioned by the British Association of Otolaryngologists, Head and Neck Surgeons, 1999. Clin Otolaryngol, 26, 388-393.

### Words in Noise Test

#### DESCRIPTION:

The Words in Noise Test is a measure of the participant’s/subject’s speech perception while there is competing noise. One syllable words are spoken at multiple signal-to-noise ratios to determine a patient’s degree of hearing loss. One of two word lists can be used, with 35 words each spoken at one of seven signal-to-noise ratios (from 24 to 0 dB).

#### PERMISSIBLE VALUES:

Correct word recognition as a percentage

#### PROCEDURE:

Thirty-five words from the Northwestern University Auditory Test No. 6 in are played from a compact disc. Test can be completed in less than 5 minutes.

#### COMMENTS:

The test has been used in adults and children

#### REFERENCES:

Wilson RH. Development of a speech-in-multitalker-babble paradigm to assess word-recognition performance. J Am Acad Audiol 2003;14:453-470.

Wilson RH, Burks CA. Use of 35 words for evaluation of hearing loss in signal-to-babble ratio: A clinic protocol. J Rehabil Res Dev 2005;42.

Wilson RH, McArdle RA, Smith SL. An Evaluation of the BKB-SIN, HINT, QuickSIN, and WIN Materials on Listeners With Normal Hearing and Listeners With Hearing Loss. J Speech Lang Hear Res 2007;50:844-856.

Wilson RH, McArdle R. Intra- and inter-session test, retest reliability of the Words-in-Noise (WIN) test. J Am Acad Audiol 2007;18:813-825.

Wilson RH, Farmer NM, Gandhi A, Shelburne E, Weaver J. Normative data for the Words-in-Noise Test for 6- to 12-year-old children. J Speech Lang Hear Res 2010;53:1111-1121.

McArdle R, Carlo M, Wilson R. Words-in-Noise-Test: English and Spanish. Presented at: American Speech-Language-Hearing Association 2009; New Orleans, LA, 2009.

## Voice, Speech, and Language

### Voice Handicap Index (VHI)

#### DESCRIPTION:

The Voice Handicap Index (VHI) is a 30-item questionnaire that queries the participant/subject on the physical, functional, and emotional effects of voice handicap. Each question is rated on a scale from 0 (Never) to 4 (Always).

#### PERMISSIBLE VALUES:

Total scores range from 0-120.

#### PROCEDURE:

Self-administered

#### COMMENTS:

Adults

#### REFERENCES:

Rosen, CA, Lee, AS, Osborne, J, Zullo, T & Murry, T. Development and validation of the voice handicap index-10. Laryngoscope, September 114 (9): 1549-56