

TITLE: Infections of the Labyrinth

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Labyrinthitis, or inflammation of the inner ear, may be caused by a variety of agents. It may be part of a systemic process or may be the result of an invading agent. Non-infectious causes of labyrinthitis, such as autoimmune labyrinthitis or that resulting from other systemic processes have been covered in other Grand Round presentations. The focus of this presentation is that of infections of the labyrinth. A variety of organisms may infect the labyrinth, resulting in vestibular manifestations, cochlear manifestations, or both. Agents affecting the labyrinth include bacterial, viral, and fungal infections.

Pathogenesis:

Labyrinthine infection usually occurs by one of the three most common routes. These include hematogenous spread, from the meninges, or from the middle ear space. Meningogenic labyrinthitis occurs through the internal auditory canal (IAC), the cochlear aqueduct or both and occurs more frequently in the pediatric population. The immature immune system of infants is not developed enough to prevent spread from a meningo-encephalitis to the nearby inner ear. Also, the patency of the cochlear aqueduct found at younger ages facilitates spread of infection. It has been estimated that 82% of children less than 16 years of age will have an open aqueduct as compared to 30% over age 60. Temporal bone studies have demonstrated invasion of leukocytes and bacteria through the subarachnoid space in the IAC and along perineural and perivascular spaces following the eighth cranial nerve. The ganglion, canal, and modiolar spaces also become involved with eventual penetration of the perilymphatic scalae. In similar studies, inflammation and fibrosis was found to involve the cochlear aqueduct and the region of the scala tympani adjacent to the cochlear aqueduct.

Hematologic labyrinthitis occurs from blood borne infections and is the least common route of spread to the labyrinth.

Tympanogenic labyrinthitis results from extension of infection from the middle ear, mastoid air cells, or petrous apex. The most common of these is otitis interna following an acute or chronic otitis media from spread through the round or oval window. The round window is the more common of the two. Large intercellular spaces in the round window are the proposed route

of spread from the middle to the inner ear. Temporal bone studies have shown that the round window membrane may be thickened by inflammatory cell infiltration and the presence of a fibrinous precipitate in the perilymph adjacent to the round window. Tympanogenic labyrinthitis may also occur in association with cholesteatoma causing bony erosion and penetration of the perilymphatic spaces. This usually involves the horizontal semicircular canal.

Bacterial Infections:

There are two types of labyrinthitis associated with bacterial infections: toxic and suppurative labyrinthitis. Toxic labyrinthitis results from a sterile inflammation of the inner ear following an acute or chronic otitis media or early bacterial meningitis. Bacterial toxins penetrate the round window, IAC, or cochlear aqueduct and cause an inflammatory reaction in the perilymphatic space. This toxic labyrinthitis produces mild high frequency hearing loss or mild vestibular dysfunction. Treatment of the precipitating otitis or meningitis with appropriate antibiotics and possible myringotomy usually leads to resolution of the otitis interna without permanent sequelae.

Suppurative labyrinthitis involves direct invasion of the inner ear by bacteria. This may result from bacterial otitis or meningitis. Meningogenic labyrinthitis often produces bilateral symptoms where tympanogenic labyrinthitis usually results in unilateral symptoms. The inflammation typically involves both the cochlea and vestibular organs. Four pathologic stages have been identified along which an episode of suppurative otitis interna may typically progress: The serous or irritative phase is characterized by the production of immunoglobulin rich exudates within the perilymph. This leads to biochemical changes in the fluids and likely alters the endocochlear potential that exists between the perilymph and endolymph. The second is the acute or purulent stage and involves bacterial and leukocyte invasion of the perilymphatic scala. Progression of exudates formation with high protein content further alters fluids in the inner ear and predisposes to the formation of hydrops. Blood vessel dilation and thrombosis as well as end organ degeneration and necrosis are seen in this stage. The fibrous or latent stage follows with the proliferation of fibroblasts and granulation tissue within the perilymph. Finally, the osseous or sclerotic stage occurs and involves new bone deposition throughout the involved labyrinth. Fibrous changes in the labyrinth may be seen within 2 weeks post-infection and the process of bony obliteration may begin as early as 2 months after onset of illness.

Purulent labyrinthitis is a medical emergency warranting prompt evaluation and implementation of therapy. The patients present with severe vertigo, nausea and vomiting, and profound hearing loss. Symptoms associated with meningitis such as nuchal rigidity, headache, and altered mental status as well as those associated with otitis media, like otalgia or otorrhea, should be sought during evaluation. Appropriate management includes hospitalization, hydration, vestibular suppressants, and parenteral antibiotics that have good CSF penetration. Patients with signs of meningeal inflammation should undergo lumbar puncture and culture of CSF to identify the causative agent and direct antibiotic therapy. Patients presenting with associated acute otitis media benefit from myringotomy to facilitate adequate drainage of the infection. Chronic otitis media, with or without cholesteatoma, may necessitate mastoid surgery. This is usually reserved for patients with minimal improvement after 24-48 hours of appropriate antibiotic therapy if signs of meningitis develop in a patient who did not present with these signs.

Bacterial Meningitis: The most common causative pathogens of bacterial meningitis are the encapsulated organisms *H. influenzae*, *N. meningitidis*, and *S. pneumoniae*. These three organisms account for about 80% of bacterial meningitis cases world wide. In the past, *H. influenzae* was the most prevalent accounting for 70%, followed by *N. meningitidis* with 20% and *S. pneumoniae* at 13%. Since the advent of the Hib vaccine, there has been a significant reduction (55% reduction) in the overall number of cases of bacterial meningitis and a shift in the predominant organism to pneumococcus (47%) followed by *N. meningitidis* (31%).

The incidence of postmeningitic hearing loss is reported to be in the range of 10-20% and seems to occur early in the disease. The hearing loss may be recognized during the acute infection or not until months to years after the event, especially in prelingual children or those who suffer other post-meningitic neurologic sequelae. Hearing loss is most often bilateral, severe to profound, and permanent. Few patients have been found to have fluctuation, improvement, or progression of their hearing loss over time. Treatment in the acute phase consists of antibiotic coverage of the infecting agent. There exists evidence of a benefit of steroid therapy with bacterial meningitis in reducing the incidence of post-meningitic hearing loss.

Syphilis: Both congenital and acquired syphilis may affect the labyrinth. Transplacental transmission of *Treponema pallidum* results in congenital syphilis. When symptoms are present at birth it is known as the infantile form and when manifest later in life it is known as the tardive form. Vertical transmission is most likely to occur with primary maternal infection, which carries a 70-100% transmission rate. Early congenital syphilis is associated with a high fetal and infant mortality rate and systemic symptoms that outweigh vestibulocochlear symptoms. Late congenital syphilis may present as a sudden sensorineural hearing loss (SNHL), often associated with vestibular symptoms. SNHL most frequently occurs between 25-35 years of age, but may occur before age 10 or after age 35. Audiometric findings in early congenital syphilis are a symmetrical, profound, flat SNHL, whereas that of late congenital syphilis tends to be asymmetric, fluctuating, or progressive and is associated with low speech discrimination scores out of proportion to the pure tone average. Acquired syphilis may present with SNHL, most often during secondary or tertiary disease and is similar to that of late congenital syphilis. Additional findings include Hennebert's or Tulio's sign, abnormal ABR with increased interpeak latency and diminished wave V, or an abnormal ENG indicating a peripheral vestibular disorder and/or unilateral weakness.

Diagnosis of *T. pallidum* infection is by serologic testing for specific *T. pallidum* antibodies (FTA-ABS), and confirmed by specific microhemagglutination assay or Western Blot analysis to detect IgG or IgM.

Treatment for otosyphilis is with high dose parenteral penicillin with duration depending on the stage of disease. Primary acquired syphilis may be adequately treated with a one-time dose of 2.4 million units of Penicillin G. Long term antibiotic therapy may be necessary as replication time of *T. pallidum* may be as long as 90 days. Concomitant use of systemic steroids has been shown to be of some benefit. In particular, speech discrimination scores improved in 50% of cases treated with steroids.

Temporal bone findings in congenital and acquired syphilis are similar. Early congenital

and late acute secondary or tertiary syphilis are characterized by a meningo-neuro-labyrinthitis. This involves round cell invasion of CNVIII, with resultant degeneration of the organ of Corti, spiral ganglion, and nerve fibers. This round cell invasion leads to deposition of fibrinous exudates and hemorrhage. Late congenital or late latent or tertiary syphilis demonstrates an obliterative endarteritis, gumma formation, and a round cell osteitis of the otic capsule.

Viral Infections

Viral labyrinthitis may present in one of three ways: 1) congenital infection, 2) as part of a systemic viral illness, or 3) as isolated involvement of the inner ear. Acquired viral infection of the labyrinth, both systemic and isolated, usually presents with sudden SNHL or vestibular neuritis. Much of the evidence linking viral agents to labyrinthitis is circumstantial, as it is very difficult to prove a causal relationship with this illness. Definitive causality is achieved by fulfilling Koch's three postulates. First, there must be a clinical association between a specific infectious agent and distinct inner ear diseases. Second, the infectious agent must be identified in or isolated from the affected labyrinth. Last, a similar disease is observed in experimental animals infected with the agent. Thus far, these criteria have only been met with CMV and mumps labyrinthitis, but current studies make a strong case for Herpes simplex also. Other suspected pathogens include rubella, rubeola, influenza, varicella-zoster, EBV, poliovirus, RSV, adenovirus, and parainfluenza virus.

Cytomegalovirus: Cytomegalovirus (CMV) is the most common congenital infection in the US and is thought to be the most common infectious cause of congenital deafness. Approximately 1% of all live births demonstrate CMV infection, which translates to 30-40,000 infected newborns annually. 6-8,000 of these will exhibit clinical sequelae of CMV at some point in their lifetime. Approximately 4000 cases of SNHL are attributed to CMV each year. Intrauterine infection most often occurs after primary infection of a previously seronegative mother. Neonatal CMV infection can occur by transplacental transmission, traversing an infected birth canal or ingestion of infected breast milk.

Most CMV infections are asymptomatic, with the remaining infections revealing symptoms during the neonatal period. The majority of the symptomatic patients will demonstrate the typical cytomegalic inclusion disease (CID) of the newborn. Low birth weight, jaundice, hepatosplenomegaly, petechiae or purpura, microcephaly, and psychomotor retardation all characterize CID. As many as 65% of these children will manifest SNHL which is most often bilateral and severe to profound. Infants with asymptomatic CMV at birth develop varying degrees of SNHL in a minority of cases. Risk factors for late development of SNHL include periventricular calcifications or significantly elevated maternal antibody titers throughout pregnancy.

The diagnosis of congenital CMV is made by isolating the virus from the urine during the first few weeks of life or by identifying anti-CMV IgM antibodies in the umbilical cord blood. Antepartum diagnosis may be possible by viral isolation from amniotic fluid culture.

There exists no current therapy for congenital infection or to prevent primary maternal infection. Treatment with acyclovir has decreased viral shedding in the urine but fails to show an improvement in clinical course. Gancyclovir and foscarnet are newer drugs shown to have

anti-CMV effects, but their efficacy in congenital infection is not yet established. CMV vaccine development is currently experimental and trials with live-attenuated virus have shown both humoral and cellular immunity induction. Concerns over latent infection with live virus and failure of long term immunity has precluded use of the vaccine. Vaccines utilizing envelope glycoproteins as antigens have shown some promise.

Temporal bone studies of infected infants have revealed characteristic CMV inclusions in cells of the stria vascularis and epithelial cells of the labyrinth in the utricle, saccule, and semicircular canals. This indicates fetal viremia which leads to infection of the endolymphatic spaces as the pathogenic mechanism of intrauterine infection. Animal models have revealed meningogenic labyrinthitis with CMV spreading through the cochlear aqueduct and along CN VIII to involve the perilymphatic spaces.

Rubella: The rate of congenital rubella infection has dropped considerably since the use of the first rubella vaccine in 1969. In 1969, 58/100000 persons had congenital rubella, and this figure has diminished to 0.5/100000 persons in 1983. Fetal infection with rubella, unlike CMV, has only been demonstrated with primary maternal infection. First trimester infections have the highest risk for transplacental fetal transmission and up to 90% of infected neonates demonstrate symptoms of congenital rubella syndrome. Second or third trimester infection has shown a 50% transmission rate and approximately 25-50% will be symptomatic.

The classic findings in congenital rubella syndrome include cataracts, heart malformations, and SNHL. Others may include retinopathy, jaundice, thrombocytopenia, psychomotor retardation, microcephaly, hepatosplenomegaly, pneumonitis, encephalitis, and long bone radiolucencies. Half of symptomatic infants will have hearing loss and an additional 20% of those with silent infection will have hearing impairment.

Diagnosis of rubella is made by culture and isolation of the virus from the urine of infected infants. Also, serology of anti-rubella IgM or a rise in IgG titers. No treatment exists for congenital rubella infection and management centers on accurate diagnosis and follow up with auditory rehabilitation. Prevention of maternal infection with widespread vaccination programs is paramount. Antepartum screening of maternal rubella immunity is now routine and non-immune pregnant women are counseled about risk of infection. Fetal infection after vaccination can occur and although the risk of hearing loss in these infants is small, vaccination during pregnancy is contraindicated.

Temporal bone studies have revealed cochleosaccular changes of the Scheibe type. Other findings include partial collapse of Reissner's membrane, abnormalities of the tectorial membrane, and atrophy or partial destruction of the stria vascularis. The organ of Corti, spiral ganglion, utricle, and semicircular canals remain unaffected in rubella infection.

Mumps: The mumps virus is a paramyxovirus that causes a symptom complex of parotitis, orchitis, meningoencephalitis, and in 0.05% of cases, hearing loss. The hearing loss usually occurs at the end of the first week of the parotitis; it is unilateral in 80% of patients; and it can range from a mild, high frequency SNHL to a profound SNHL. Vestibular involvement is uncommon.

Temporal bone studies have shown alterations of the cochlear duct structures, most notably in the basal portion, in the organ of Corti and stria vascularis with collapse of the Reissner membrane. Associated findings include deformation and detachment of the tectorial membrane and moderate loss of spiral ganglion cells in the basal turn. The late development of deafness is thought to be consistent with labyrinthine involvement from CSF, but mumps meningitis has not been correlated with the development of SNHL.

In the acute phase, the mumps virus may be isolated from the throat or from CSF; the diagnosis also may be confirmed by documenting a fourfold increase in mumps antibody titers between acute and convalescent sampling. Audiometric testing should be performed to document the degree of hearing loss sustained; the hearing loss is cochlear rather than retrocochlear.

Measles: The rubeola virus is the causative agent in measles, a systemic illness characterized by rash, conjunctivitis, and mucosal Koplik spots. The incidence of measles induced hearing loss is less than 1/1000 cases. Prior to the development of the measles vaccine it was estimated to be responsible for 3-10% of cases of acquired deafness. Measles encephalitis occurs in 0.1% of cases and has an overall mortality rate of 15%, with 25% of survivors having permanent SNHL or other CNS sequelae.

The hearing loss in measles is most often seen in conjunction with a rash. It is sudden in onset and varies in severity from mild or moderate to profound. The impairment may be unilateral or bilateral, sometimes with asymmetric involvement, is worse in the high frequencies, and is permanent. Up to 70% of patients also have vestibular losses demonstrable by reduced or absent caloric responses.

Diagnosis is made by viral isolation from throat or urine culture, detection of viral antigens in pharyngeal epithelial cells, presence of IgM antibodies, or a rise in IgG titers. Widespread vaccination with live-attenuated rubeola virus has led to a 98% reduction in the incidence of measles since the 1960's. Hearing aids or cochlear implantation may be of benefit in affected patients.

Temporal bone studies in animals and humans have shown viral antigen in the neuroepithelial cells of the cochlear and vestibular organs, the neurons of CN VIII, and the spiral and vestibular ganglia. Giant cells typical of measles infection were found in the organ of Corti and the spiral ganglion cells. Cochlear degeneration and atrophy of the stria vascularis is maximal in the basal turn. The tectorial membrane is thickened or distorted. Membranous collapse and macular degeneration is seen in the utricle and saccule. The extensive degeneration of cochlear neuroepithelial structure likely explains the typical lack of recovery following measles induced hearing loss.

Varicella-Zoster: Primary varicella-zoster virus (VZV) infection results in chicken pox with its characteristic rash. Hearing loss has occasionally been associated with chicken pox but it is typically a conductive hearing loss resulting from an otitis media with effusion. Zoster is a reactivation of latent virus within affected ganglia that results in a rash along the respective dermatome. Herpes zoster oticus or Ramsay Hunt syndrome refers to viral reactivation from the geniculate ganglion of the facial nerve with the development of vesicles over the sensory

distribution of the nerve.

Patients present with painful vesicles involving the external auditory canal and pinna, otalgia, and facial weakness or paralysis. Approximately one-third of patients have auditory or vestibular symptoms that may include decreased hearing, hyperacusis, tinnitus, disequilibrium or vertigo. The hearing loss is in the high frequencies and associated ABR testing can show either a cochlear or retrocochlear abnormality. Caloric testing often reveals absent responses in the affected ear.

Diagnosis of VZV is primarily clinical, although viral culture of vesicular fluid or viral antibody titers may be used for confirmation. The natural course of the illness is spontaneous recovery of auditory and vestibular function over several weeks. The severity of the hearing loss and presence of vestibular symptoms have been inversely related to spontaneous recovery. Antiviral therapy with acyclovir and more recently with gancyclovir has been shown to speed resolution of skin lesions and decrease pain. Concomitant treatment with steroids may provide some resolution of facial nerve and/or labyrinthine inflammation. Treatment should also include appropriate analgesic therapy. Studies of the effect of the recent VZV vaccine in Ramsay Hunt syndrome are, to date, lacking.

The pathogenic mechanism of herpes zoster oticus is reactivation of latent virus within the geniculate ganglion with resultant spread of inflammation along CN VII to also involve CN VIII. Temporal bone studies have supported this mechanism. In the subacute stage, active neuritis involves the entire facial nerve, maximally at the geniculate ganglion. Inflammatory cells have also been found along the vestibulocochlear nerve and within the macula of the utricle and saccule. Destruction of the organ of Corti was near complete in the basal turn and to some extent involved the middle turn as well. Chronic changes include degeneration of neural structures and sensory end-organs as well as labyrinthine fibrosis and ossification.

Herpes Simplex: Herpes simplex virus (HSV) may be related to labyrinthine infection by two distinct mechanisms. HSV-1 has been hypothesized as a cause of idiopathic sudden sensorineural hearing loss (ISSNHL). Similar to the proposed theory of HSV-1 reactivation in the geniculate ganglion as a cause of Bell's palsy, it has been proposed that reactivation of HSV-1 in the spiral ganglion leads to SSNHL. HSV-2 is known to cause neonatal herpes simplex encephalitis. Extension of the meningoencephalitis along CN VIII to the labyrinth is a potential cause of acquired SNHL.

Recent studies have shown that both HSV-1 and 2 can infect the labyrinth. Animal models of ISSNHL are based on HSV infection. Neuroepithelial cells of the cochlea, utricle, saccule, and semicircular canals are all affected by these viruses. Although circumstantial evidence and serologic, molecular and immunohistochemical studies implicate HSV in auditory or vestibular loss in humans, definitive proof is lacking. Recent studies have shown that treatment of ISSNHL with antiherpes (acyclovir) drugs does not provide any beneficial effect than with treatment with steroids alone.

Human Immunodeficiency Virus: Auditory and vestibular complaints are rare in AIDS patients although sudden hearing loss, tinnitus and vertigo have all been cited in the literature. The etiology of hearing loss in HIV is unclear. Potential mechanisms include primary

labyrinthine infection with HIV, secondary infection by opportunistic pathogens, neoplasm involving the inner ear, or ototoxicity of anti-HIV drugs. Hearing loss has been shown to occur in about half of AIDS patients. The most common finding is a mild SNHL although increasing loss may be seen in the low and high frequencies. ABR testing reveals both cochlear (prolonged wave I latency) and retrocochlear (prolonged wave V latency and wave III-V interpeak latency) abnormalities. It is thought that at least part of the hearing loss in these patients is attributable to central auditory dysfunction.

Temporal bone studies have shown variable findings. One study revealed isolation of CMV, adenovirus 6, and HSV-1 from the inner ears of AIDS patients. The sensory and neural components of these ears did not appear to be affected and there was no evidence of viral induced inflammation. In other studies, vestibular end-organs found hair cell inclusion bodies, virus-like particles and malformation of hair bundles. A direct neuroepithelial infection with HIV was presumed based on these findings. Other studies have shown *Cryptococcus* and *Pneumocystis* within the temporal bone, suggesting opportunistic otitis interna.

Fungal Infections

Fungal labyrinthitis is exceedingly rare outside the context of host immunocompromise. The number of reported cases is increasing with concomitant increase in the prevalence of HIV infection and the use of immunosuppressive doses of steroids or chemotherapy. High risk populations include severe diabetics, patients undergoing chemotherapy, organ transplant recipients and AIDS patients.

Fungal agents described in the literature as causative organisms or fungal labyrinthitis include *Mucor*, *Cryptococcus*, *Candida*, *Aspergillus*, and *Blastomyces*. Patients with these infections were found to have inflammation and fungal invasion along the IAC and cochlear aqueduct which extended to involve both the cochlear and vestibular labyrinths.

Treatment of this infectious process involves systemic antifungal therapy and optimization of host immune defenses if possible. Hearing loss induced by fungal labyrinthitis is often severe and permanent. Evaluation for amplification may be warranted.

Protozoan Infections

Toxoplasmosis: Acquired infection with *Toxoplasma gondii* is usually asymptomatic or may produce a nonspecific illness with myalgias, fatigue, and lymphadenopathy. Congenital infection, by contrast, may lead to severe malformations in the fetus. Congenital toxoplasmosis is typified by the triad of chorioretinitis, hydrocephalus, and intracranial calcifications. Additional features of the disease may include microcephaly, cataracts, microphthalmia, jaundice, and hepatosplenomegaly. The estimated incidence of congenital toxoplasmosis in the US is near 3000 cases annually. The highest risk of transmission to the fetus occurs with primary maternal infection during the third trimester with a 60% transmission rate. The highest risk for severe manifestation of infection in the fetus occurs with early maternal infection, between 10–24 weeks gestation. 75% of neonates will be asymptomatic at birth, 15% will have ocular problems and 10% will demonstrate severe manifestations. As many as 85% of symptomatic infants at birth will later present with decreasing visual acuity or intellectual function, hearing loss or

precocious puberty.

Pregnant women with evidence of infection may elect to have screening testing performed to determine fetal infection. Current screening methods include PCR analysis of amniotic fluid or IgM assays or quantitative maternal/fetal IgG analysis of umbilical cord blood samples. Prenatal treatment has been shown to reduce both transmission and severity of illness in the fetus. Treatment is with combination therapy of pyrimethamine and sulfonamide. Neonates with documented congenital infection should be given this regimen for the first year of life with the addition of folic acid supplements.

Clinical Presentation:

Patients with an internal otitis may present with only auditory dysfunction-acute cochlear labyrinthitis, only vestibular dysfunction-acute vestibular labyrinthitis, or both- acute cochleovestibular labyrinthitis. Acute cochlear labyrinthitis, also known as idiopathic sudden sensory neural hearing loss (ISSNHL), is defined as a minimum of 30 dB deficit in three contiguous frequencies over a period of less than 3 days in a previously healthy individual. Three common pathogenic theories exist to explain ISSNHL. These are viral infection, vascular phenomenon, and intralabyrinthine membrane rupture. The majority of evidence in the literature, although circumstantial, supports a viral induced mechanism. 90% of ISSNHL is unilateral, it is widely variable in severity, and is often accompanied by aural fullness and tinnitus. Patients report a sudden onset, painless loss of hearing. 30-50% of patients report a preceding or current URI. Vestibular symptoms or disequilibrium may be present.

The differential diagnosis of ISSNHL in addition to infectious etiologies includes autoimmune labyrinthitis, head/temporal bone trauma, neoplasm, ototoxicity, and vascular accidents. Evaluation of these patients begins with complete physical exam with special emphasis on otologic and neurological examination. Laboratory tests are directed toward ruling out specific causes of hearing loss and include CBC, ESR, blood glucose and FTA-ABS. Audiologic evaluation is instrumental in the evaluation of these patients and ENG testing is undertaken if indicated. Imaging studies such as CT scan or MRI can be useful to look for bony abnormalities, neoplasm, or central demyelination.

Many attempts at pharmacological treatment of ISSNHL have been made, including use of vasodilators, anticoagulants, plasma expanders, steroids, carbogen, and antivirals. The majority of these regimens have not been proven to be beneficial through clinical trials. The exception to this is oral steroid therapy, and their efficacy has been well described in the literature. Patients who benefited most from steroid therapy were those who demonstrated a moderate hearing loss (40-90dB PTA in the infrequency range) on initial exam. Despite all the supporting evidence for a viral etiology in ISSNHL, antiviral therapy has been shown to be of no additional benefit in combination with steroids vs. steroid therapy alone.

Overall, it is estimated that between 30-70% of patients will have partial or complete recovery of hearing. The prognosis for recovery seems to be related to patient age, time from onset to presentation, type of audiogram, and presence of vestibular symptoms. Patients younger than 40 have a higher chance for recovery. Patients seen within 10 days of onset and started on steroid therapy in that time have better outcomes. A mild hearing loss at presentation is

associated with recovery in nearly 100% of cases. Those patients with moderate hearing loss will spontaneously recover function in 38% of cases; this can be increased to 78% with steroid therapy. Profound hearing loss carries the worse prognosis with less than 20% of cases having any recovery regardless of treatment. The presence of vertigo is associated with more extensive labyrinthine pathology and is a poor prognostic factor. Hearing thresholds at 6 weeks post illness are often what the patient will have permanently. At this time, hearing aid fitting or cochlear implant may be considered for those patients with severe or profound losses.

Acute vestibular labyrinthitis, otherwise known as vestibular neuritis, is defined as a sudden unilateral vestibular weakness in the absence of concomitant auditory or CNS dysfunction in a previously healthy person. Diagnostic criteria for this entity, as set forth by Coates include: 1) an acute, unilateral, peripheral vestibular disorder without associated hearing loss, 2) occurrence predominantly in middle age, 3) a single episode of severe prolonged vertigo, 4) decreased caloric response in the involved ear, and 5) complete subsidence of the symptoms within 6 months. Patients will report acute onset of vertigo of varying severity, not uncommonly associated with nausea and vomiting. Symptoms may progressively worsen over the first 24 hours and during this time the patient may complain of severe imbalance, falling and inability to focus the eyes. Symptoms gradually dissipate over several weeks to months.

The differential diagnosis of vestibular neuritis includes Meniere's disease, vestibular schwannoma, labyrinthine fistula, cerebellar infarction, multiple sclerosis, and disequilibrium of aging. Evaluation of these patients begins with physical exam which will often reveal an obviously ill person who is pale, clammy and sweating. They remain very still throughout the interview and exam as any movement precipitates the vertigo. Examination is often unremarkable other than gait unsteadiness and nystagmus. Audiologic testing is indicated to evaluate for associated cochlear loss. ENG may reveal nothing more than spontaneous nystagmus in the acute phase but later will likely demonstrate a reduced or absent response on the involved side. If the history is suggestive of a CPA mass or cerebellar infarct, imaging with CT or MRI is warranted.

Treatment is supportive and includes hydration, antiemetics, and vestibular suppressants. Some authors state that this disease is benign and most patients recover within 2 months, implying a return to normal function. Others discuss patients' recovery over 2-6 months but speak on terms of compensatory mechanisms adjusting to the permanent peripheral vestibular loss. Histopathologic studies which have demonstrated severe nerve fiber loss and cellular loss within the cristae of the semicircular canals lend support to permanent loss of vestibular function and subsequent compensation by other mechanisms.

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