an older gentleman enters a coffee shop on the upper west side of Manhattan. He can barely lift his feet as he walks and has a wide gait with little knee flexion. His gait is slow and he is inattentive. He stops for a minute or so and gazes around the shop, down at the floor, and then back to the door he just entered. His posture is not straight. His body has a slight lean backward as he walks. He continues to walk, and as he turns his body slightly to the left, he almost loses his balance. The man’s arms look relaxed and they swing in a typical way while moving. It takes him about 10 minutes to walk from the door he entered to the counter of the coffee shop about 30 feet away. Once at the counter, he appears unsure of what to order and then orders his usual hazelnut coffee. Although his feet appear as if they are stuck to the floor as he tries to walk, he manages to make it safely to a table nearby. He sits to enjoy his coffee over the next 30 minutes. Once done, it takes the gentleman about 10 minutes to exit the door and very slowly walk to his apartment, which is two doors down from the coffee shop.

The gentleman in the case study has the distinctive gait and other common signs and symptoms of possible normal pressure hydrocephalus (NPH) in older adults. NPH is often the cause of hypokinetic gait in older adults. The triad of symptoms in NPH are gait disorder, cognitive impairment, and urinary continence problems. NPs need to consider the possibility of NPH in older adults with a hypokinetic gait.

Key words: cognitive impairment, gait disorder, hypokinetic gait, normal pressure hydrocephalus
States, or 5% of the population may have NPH. The numbers are expected to increase due to extended longevity. In 2005, an international study group developed and reported comprehensive guidelines for NPH.

In NPH, there is an enlargement of the brain’s ventricular system due to an excess of cerebrospinal fluid (CSF) thought to be related to decreased reabsorption of CSF by the arachnoid villi surrounding the exterior of the brain (see Normal flow of CSF). As the ventricles slowly enlarge from the accumulation of CSF, tissue compliance increases and further ventricular enlargement results. Subsequently, increased intracranial pressure is transient as the ventricles are able to accomodate more CSF. As the ventricles continue to enlarge, edema, and permanent changes in the shape of the ventricles may cause periventricular and vascular damage. Additionally, compression of brain parenchyma and vessels and the accumulation of toxins due to slow refreshment of CSF and decreased clearance of metabolites increases CSF-flow obstruction and progressive ventriculomegaly. Signs and symptoms of NPH occur as various areas of the brain are compressed.

The etiology of NPH is unclear. Chrysikopoulos states the perplexing feature of NPH is the progressive enlargement of the ventricles in the absence of mechanical obstruction of CSF, along with a normal mean intraventricular and mean intracranial pressure. NPH can be either idiopathic or secondary to head trauma, meningitis, or subarachnoid bleed. The author hypothesized that in NPH, alterations in the normal systolic-diastolic cycle of blood flow in the brain will disrupt the normal propulsion of CSF. Abnormal ventricular systole in the brain is thought to be caused by stiff and narrowed arteries due to atherosclerosis and hypertension. Poor circulation of CSF is proposed to result in toxic/osmotic effects that may include cellular and axonal dehydration. Chrysikopoulos states there is evidence linking NPH to diseases of the cerebral arteries.

Krauss et al investigated vascular risk factors and arteriosclerotic disease in NPH in older adults. The sample included 65 participants who ranged in age from 50 to 87 with a mean age of 70.8 years. Forty-six percent were men, and 54% were women. Variables examined included systemic arterial hypertension, diabetes mellitus, smoking, hyperlipidemia, hypercholesterolemia, obesity, and cardiac, cerebrovascular, and other arteriosclerotic disease. A highly significant association was found between NPH and systemic arterial hypertension. A positive relationship was also found between the severity of clinical symptoms of NPH and the presence of systemic arterial hypertension, especially for severe gait disturbance. Diabetes mellitus was found to be associated with NPH; however, when the variables were examined using logistic regression, only systemic arterial hypertension was found to have a significant association with NPH.

Since NPH typically is most common in individuals in their sixth and seventh decades, its characteristic triad of symptoms can be easily mistaken for other conditions attributed to aging, thereby delaying its diagnosis. The diagnosis of NPH does not require the presence of all three symptoms. The first symptom to be exhibited is usually a change in gait, while cognitive and urinary changes occur later. In fact, if cognitive impairment occurs before disturbances in gait then NPH is probably not present.

### Distinctive gait of NPH

NPH is a diagnostic challenge with gait impairment as the cardinal sign. Gait disturbance is an early sign of NPH. The distinctive gait is described as having reduced velocity, diminished stride length, broad-based, and reduced foot-to-floor clearance. There is an increased foot angle, with the feet rotated outward. Step height is greatly diminished, giving the appearance that the person’s feet are stuck to the floor.

Older adults with NPH tend to hesitate when initiating ambulation or turning. They are unsteady and lose their balance easily. NPH is distinguished from a similar gait in Parkinson disease by the preservation of reciprocal arm swing when walking. Also, a levodopa challenge may be done to differentiate between NPH and Parkinson disease. Patients with NPH will not respond to levadopa.

Those with NPH struggle to rise from a seated position and have difficulty initiating the first steps in walking. Climbing stairs may be problematic, as their step height is diminished and their stride length is shortened. Some patients may only present with a history of frequent falls. Individuals with NPH may also appear to lean backwards slightly when standing and ambulating and have a larger sway area than healthy individuals.

### Cognitive impairment

Cognitive impairments in NPH can range from minimally detected to profoundly severe. Over time, cognitive impairments may become more generalized and more difficult to manage. In NPH, cognitive impairment typically includes inattentiveness, lack of spontaneity, and latency in recall. The processing of information tends to be slow. A fact recalled by a person with NPH is most often accurate. The answers provided to questions are frequently correct. The dementia from NPH is distinct from that noted in a person with Alzheimer disease (AD). The individual with NPH should not have difficulty with word formation or carrying out simple tasks that do not require concentration.

Differentiating between cortical and subcortical deficits is key to distinguishing NPH from other cognitive impairments and dementias. If cognitive impairment is
Gait disorder in older adults: Is it NPH?

Gait disturbance
- Appears before cognitive or urinary symptoms
- Reduced velocity
- Diminished stride length
- Broad based
- Reduced floor-to-foot clearance
- Diminished step height
- Increased foot angle
- Feet rotated outward
- Feet appear to be stuck to the floor
- Hesitates when initiating ambulation
- Hesitates when turning
- Unsteady
- Loses balance easily
- Normal reciprocal arm swing when walking

Cognitive impairment
- Inattentiveness
- Lack of spontaneity
- Latency in recall
- Slowed processing of information
- Fact recall most often accurate
- Answers provided to questions frequently correct
- No difficulty with word formation
- Can carry out simple tasks

Urinary continence problems
- Perception of pressing need to void
- Urinary frequency more than six voiding episodes in 12 hours
- Nocturia more than twice in an average night
- Episodic incontinence
- Persistent incontinence (later sign)

In addition to the triad of symptoms most often associated with NPH, there are a number of additional problems that may occur in NPH. Affected neuropsychologic and cognitive functions may include, but are not limited to, short-term memory, numeracy (math skills needed to cope with everyday life), abstract thought, concentration, dexterity, and writing skills. In addition, behavioral and psychiatric changes observed in NPH may include awakening fluctuations, fantastic confabulation, reduced alertness, easily fatigued, apathy, bipolar disorder, depression, and obsessive-compulsive disorder.

Additional problems associated with NPH

Health history and assessment

A thorough health history and physical exam are essential to efficiently and accurately diagnose NPH so that treatment can begin quickly. Delayed diagnosis and treatment have negative effects on the patient’s prognosis.

A thorough patient history of symptom onset and progression, medical history of both the patient and the family, and past and present medications are important components of the evaluation. A detailed gait history should be obtained from the patient and family about the onset of walking problems and whether the gait problems had a sudden onset or a gradual decline. A gradual decline is consistent with NPH. Many other diseases present with similar symptoms as NPH and must be considered in the differential diagnoses. Headache, visual disturbances, and nausea may be present as a result of the increased intracranial pressure.

Gait should be assessed for reduced velocity, diminished stride length, broad-based stance, and reduced foot-to-floor clearance. Also assess for an increased foot angle, with the feet rotated outward. A greatly diminished step height gives the appearance that the person’s feet are stuck to the floor. Hesitation when the individual initiates ambulation and when turning, unsteadiness, and loss of balance are consistent with NPH. The gait of NPH is distinguished from that of Parkinson through observation of posturing and arm swing.

A cognitive evaluation will typically reveal mild cognitive impairments presenting as inattentiveness, lack of spontaneity, and latency in recall. Although the processing of information tends to be slow, memory recall is accurate and answers to questions are mostly correct. Unlike those with Alzheimer disease, individuals with NPH can carry out simple tasks and do not experience difficulty with word formation and understanding.

Urinary continence issues are identified during history taking and can be further evaluated through urodynamic testing and cystometry. Factors that may contribute to urinary incontinence in older adults include decreased sensation, altered pelvic floor tone, increased intra-abdominal pressure, and medications that affect bladder function.
evaluation. It is a late sign in NPH patients and patients will initially relate that they experience urinary urgency, frequency, and nocturia. Other underlying medical issues and medications need to be ruled out before attributing incontinence to NPH.2,7,13

■ Diagnostic tests

Standardized neuropsychologic tests are useful for identifying cognitive impairment and to distinguish subcortical from cortical dementias.6 There are several screening instruments useful to determine cognitive deficits in those with NPH. The Mini-Cog and Short Portable Mental Status Questionnaire are useful to identify cognitive impairment, and the Folstein Mini-Mental State Examination can identify the severity of cognitive impairment. Visuospatial skills and executive function are assessed with the Clock Drawing Test.7 Finally, the Geriatric Depression Scale identifies depression that may present as cognitive deficiencies. These tests are helpful in determining not only whether a person is a candidate for shunting, but also how successful the shunting is when completed.6,7

Cystoscopic and urodynamic testing are useful in determining stress and/or overflow incontinence, as well as other causes of urinary symptoms such as benign prostatic hyperplasia, bladder cancer, neurogenic bladder, and cystitis.18,19 A urodynamic evaluation will show hyperactivity of the bladder.8

Radiographic imaging is used to support the diagnosis of NPH, as well as ruling out other causes of symptom presentation. In NPH, computed tomography (CT) scans reveal ventricular enlargement. Magnetic resonance imaging (MRI) results reveal significantly increased CSF in the ventricles of the brain. There is also decreased CSF in the medial subarachnoid spaces when those with NPH are compared with those with vascular dementia or with Alzheimer disease.20 The following imaging criteria may be helpful to ascertain ideal candidates for shunt placement: ventriculomegaly, improvement of symptoms after CSF drainage, normal-sized or occluded Sylvian fissures and cortical sulci, absent or moderate white matter lesions.12

In NPH, single-photon emission computed tomography (SPECT) will reveal diminished cerebral blood flow that is common in NPH. Radionuclide cisternogram differentiates communicating from obstructive hydrocephalus and determines CSF flow after radioactive material is infused into the CSF and tracer activity identifies CSF outflow obstructions.6,7,19

Tests that involve lumbar puncture show the most potential in diagnosing NPH and also identify appropriate candidates for shunt placement. A lumbar puncture reveals normal CSF pressure and normal levels of protein, glucose, and cell counts.15 McGirt et al21 conducted a 10-year retrospective study and found that NPH can be diagnosed accurately using a 3-day CSF drainage trial via spinal catheter or CSF pressure monitoring. The withdrawal of 50 mL of CSF is also used for the prognostic evaluation. There is varying specificity and sensitivity evident in the medical literature. The removal of CSF reveals transient improvement in gait and cognition.22 A CSF infusion test involves infusion of fluid into the lumbar subarachnoid space to determine a patient’s capacity to absorb CSF (CSF absorptive capacity) and shows improvement in symptoms. Symptom improvement in any of these tests indicates that ventricular shunting is an appropriate intervention (See NPH diagnostic tests).15

■ Treatments

NPH is often treated with a ventriculoperitoneal shunt (VP Shunt) to divert excess CSF away from the brain. A ventriculo-
NPH diagnostic tests

Neurologic
• CT scan reveals ventricular enlargement
• MRI reveals increased CSF in the ventricles
• SPECT reveals diminished cerebral blood flow
• Radionuclide cisternogram with radioactive tracer differentiates communicating from obstructive hydrocephalus, CSF flow, and outflow obstructions
• Lumbar puncture reveals CSF pressure, protein, glucose, and cell counts
• 3-day CSF drainage trial via spinal catheter or CSF pressure monitoring reveals transient improvement in gait and cognition
• CSF infusion test determines CSF absorptive capacity and improvement in symptoms

Cognitive
• The Mini-Cog evaluates level of cognitive ability
• Short Portable Mental Status Questionnaire evaluates level of cognitive ability
• Folstein Mini-Mental State Examination evaluates level of cognitive ability
• Clock Drawing Test identifies visuospatial skills and executive function
• Geriatric Depression Scale identifies depression

Urologic
• Cystoscopic and urodynamic testing determines causes of urinary symptoms
• A urodynamic evaluation identifies bladder hyperactivity

Following the insertion of a VP shunt, care should include positioning the individual supine 12 to 24 hours and elevating the head of the bed gradually, following the neurosurgeon’s protocol. This gradual elevation helps to prevent overshunting of CSF. Overshunting can result in collapse of the ventricles of the brain and cause bleeding. Acute intracranial hemorrhage is the primary risk following the insertion of a VP shunt and tends to be underreported. A new laparoscopic technique is being used by some neurosurgeons to insert the peritoneal portion of the VP shunt catheter. This new approach has a number of benefits when compared with the traditional approach. The length of time for surgery is shorter, less trauma for the patient, and fewer complications, especially shunt obstruction.

Individuals with a shorter duration of NPH symptoms and the presence of gait impairment are likely to improve following the insertion of a VP shunt. In a review of the literature back to 1966, Klinge, Marmarou, Bergsneider, Relkin, and Black found that gait improvement following the insertion of a VP shunt ranged from 30% to 95%. Improvement is not sudden, but occurs slowly over the weeks and months that follow the insertion of the shunt. Improvement will persist as long as the shunt is working properly.

Unlike other dementias, cognitive impairment in NPH can, in some cases, be reversed. Patients with multiple medical problems should be thoroughly evaluated so that successful reversal of NPH is not delayed. Surgical shunting provides the most benefit when performed early in the disease process. Shprecher, Schwab, and Kurlan reported that AD, in combination with NPH, is common among the elderly with hypertension. Although shunting may improve gait dysfunction, severe dementia does not improve. Therefore, shunting in patients with severe dementia is discouraged.

Complications
Shunt complication are estimated to be as follows: intracerebral hematoma 3%, infection 6%, seizure activity 3% to 11%, subdural hematoma 2% to 17%, and shunt malfunction 20%. Malfunction includes obstruction and over-and-underdrainage of CSF. Shunt obstruction is the most common complication and should be suspected when there is no improvement in symptoms or if symptoms recur.

Implications for practice
NPs and other healthcare professionals are likely to recognize the symptoms of NPH in older adults and make a difference in the quality of life of older adults and their family members. Fraser and Fraser state that all healthcare professionals need to become familiar with the gait in NPH. The gait is the cardinal sign of NPH. The ability to recognize the NPH gait can be sharpened by observing those recently diagnosed, those who just had a shunt inserted, or by reviewing a video of the distinctive gait. When a patient presents with the distinctive gait of NPH alone, or with cognitive impairment and/or urinary continence problems, a comprehensive history and physical exam is indicated to differentiate NPH from other diseases. Family-focused care is essential in obtaining an accurate history of the patient’s symptoms, behaviors, walking characteristics and pattern over time, history of falls, and activities of daily living. Family-focused care is also essential during the ongoing care of the older adult with NPH.

Evaluation of gait, changes in cognition over time and present cognitive state, and present urinary symptoms and progression of symptoms provide important indicators for diagnosing NPH. If NPH is suspected, imaging studies should be performed to identify ventriculomegaly. If ventriculomegaly is confirmed, prompt referral for neurologic or neurosurgical evaluation is essential.

Following shunt placement, improvement may develop over weeks and months. Education provides the knowl-
edge necessary for patients and families to have realistic expectations and recognize shunt complications early. They should be taught to be attentive to the return of preoperative symptoms, headaches, visual disturbances, fatigue, sleep difficulties, personality changes, and paralysis and reporting them promptly to the neurosurgeon.\(^6\)\(^,\)\(^7\)\(^,\)\(^19\) The patient and family need to be aware that headache that is relieved when the person reclines may possibly be due to over-shunting and should be reported promptly to the neurosurgeon. A CT scan may reveal the presence of collapsed ventricles. Infection near the implanted shunt itself may result in meningitis or CSF infection that may result in peritonitis. The patient and family should be taught the general signs and symptoms of infection, as well as those for meningitis and peritonitis. Any problems or concerns should be reported immediately to the neurosurgeon. Also, the patient should receive regular follow-up care with the neurosurgeon.\(^25\)

As older adults live longer, stress and burden will increase among families and individuals who take on the role of family caregiver for the older adult. As such burden and stress will be experienced in increasing levels, NPs can assist caregivers. Therefore, NPs must advocate for patients’ families and caregivers by referring them for support services through local support groups, social services, and NPH organizations. Support and knowledge can improve the quality of life for both those affected by NPH and those responsible for their care. (See NPH websites and Case study of a delayed diagnosis and recovery from NPH).

Lastly, it is important that patients and families be informed about the treatment options and prognoses when deciding on shunting intervention. NPs have an opportunity to provide unbiased information about NPH signs, symptoms, diagnosis, treatment, surgical risks, benefits, and prognosis to educate patients and families so they can make educated decisions and best care for themselves and their dependent elders.\(^6\)

### Case study of a delayed diagnosis and recovery from NPH\(^26\)

SF was 74 when his daughter realized that he was having some new problems. SF had a 10-year history of type 2 diabetes and hypertension, but started to have a problem with his walking and frequent falls. His gait was extremely slow and his feet looked as though they were glued to the floor. His stance was wide-based with little knee flexion. SF tended to lean backward a bit as he stood in place or walked. Because he had inattentiveness and the slow gait, it took him about 10 minutes to walk from one room to another in his apartment. He seemed forgetful and slower in thought, yet he was able to carry out simple tasks independently. SF had been very good with his math for most of his life and started to have difficulty managing his checkbook. He was getting forgetful and had difficulty taking his medication properly. He had urgency, frequency, nocturia, and bladder incontinence at least once a day. His daughter was concerned about his health and took him to his long-time primary care provider every 3 months and also to a geriatric specialist. Both stated there was nothing that could be done about his recent health issues and that his dementia would gradually get worse. This went on for 4 years, but he only had mild cognitive decline during this time and continued problems with walking, occasional falls, and the urinary symptoms.

SF’s daughter felt that something could be done for her father and arranged for him to be evaluated by a multidisciplinary team. The diagnosis of NPH was made when he was 78 years old. He had a neurologic assessment; a CT scan revealed dilated lateral ventricles in the brain. The withdrawal of 50 mL CSF via lumbar puncture resulted in transient improvement in his gait for about 18 hours. The ventriculoperitoneal shunt insertion into the lateral ventricle on the nondominant side of his brain resulted in gradual improvement over a 1-year period. During the first month, his social interactions improved and he was more attentive. He walked with a quad cane to avoid falling and received physical therapy three times a week at home for 1 month.

At 3 months, his gait was steady and he could walk slowly and safely in his apartment without a cane. At 6 months, his memory had improved. He was once again able to calculate simple math problems and manage his own checkbook. He walked at a normal pace without falling. One year after surgery he was able to write better, was more attentive, and had improved memory.

### REFERENCES

Gait disorder in older adults: Is it NPH?


3. Factora R, Luciano M. When to consider normal pressure hydrocephalus in gait disorder in older adults: Is it NPH?


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